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(54) **IMAGE STABILIZING APPARATUS, IMAGE PROCESSING APPARATUS, AND DETECTION METHOD**

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(52) **U.S. Cl.**
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(57) **ABSTRACT**

An image stabilizing apparatus comprises: a shake detector that detects shake; an image stabilizer that corrects the shake by moving a position on the basis of the shake detected by the shake detector; a position detector that detects and outputs the position of the image stabilizer; a determinator that determines an extraction timing at which to extract the position of the image stabilizer on the basis of a timing at which an image sensor which shoots an image is exposed; and an extractor that extracts the position of the image stabilizer, from the output of the position detector, at the extraction timing determined by the determinator.

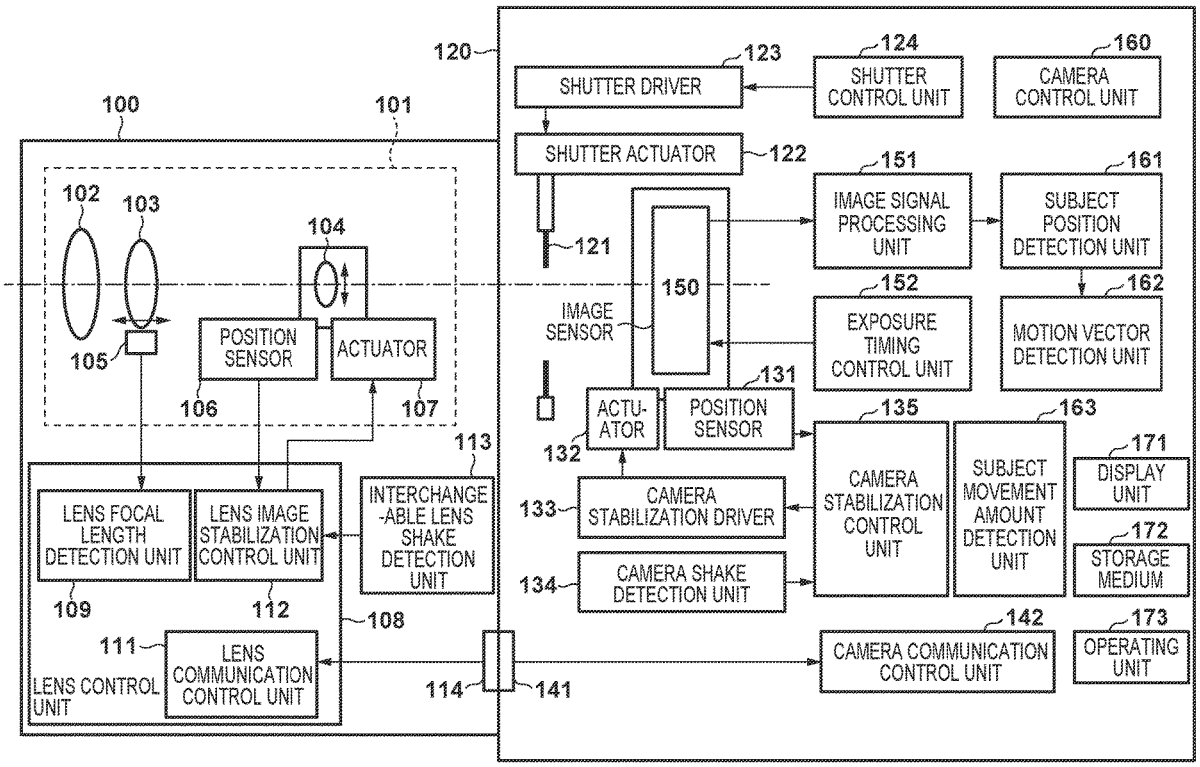
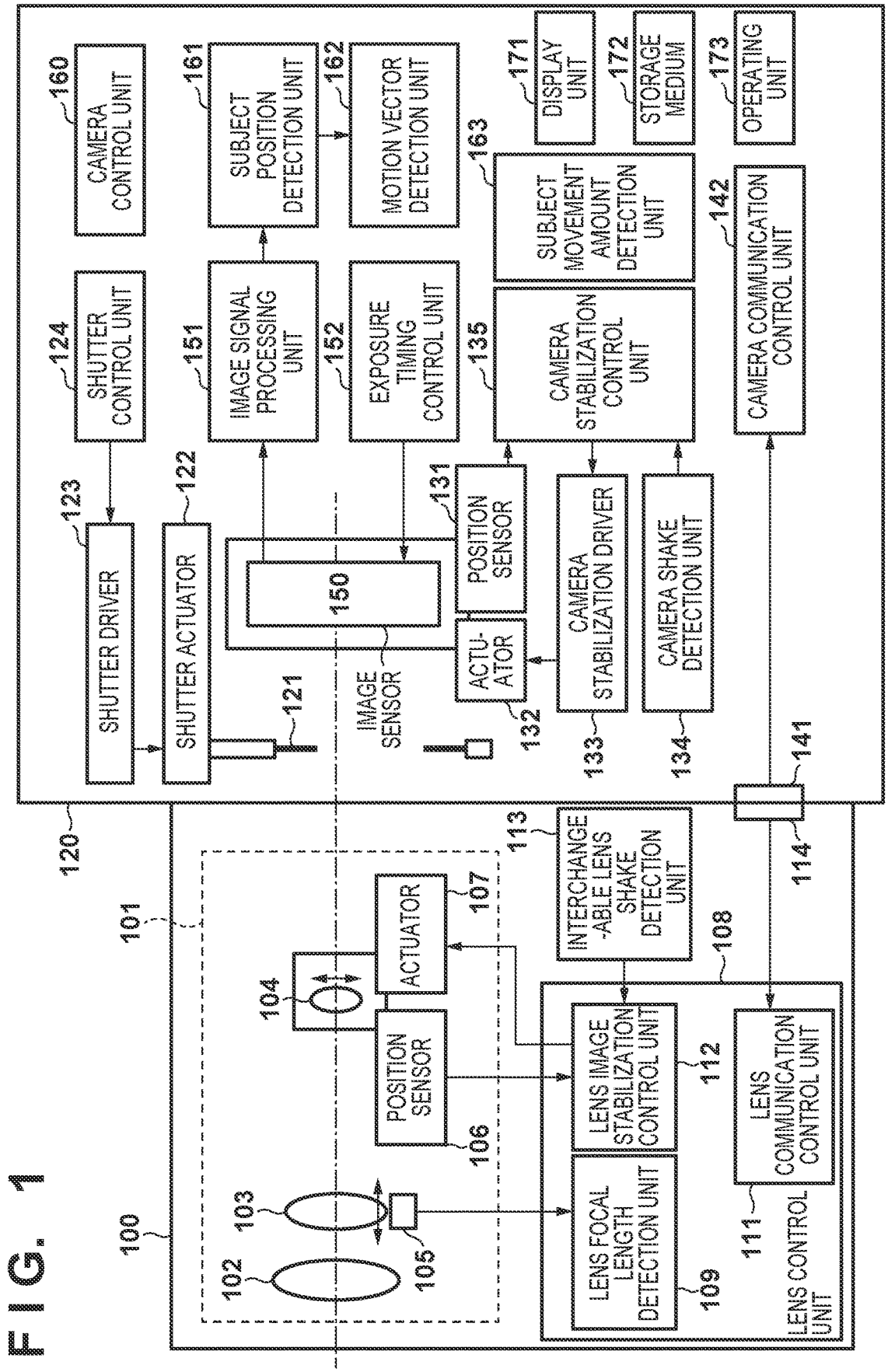


FIG. 1


100
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124
131
132
133
134
135
141
142
150
151
152
160
161
162
163
171
172
173
LENS CONTROL UNIT
LENS FOCAL LENGTH DETECTION UNIT
LENS COMMUNICATION CONTROL UNIT
LENS IMAGE STABILIZATION CONTROL UNIT
POSITION SENSOR
ACTUATOR
INTERCHANGE-ABLE LENS SHAKE DETECTION UNIT
POSITION SENSOR
ACTU-ATOR
IMAGE SENSOR
SHUTTER ACTUATOR
SHUTTER DRIVER
CAMERA STABILIZATION DRIVER
CAMERA SHAKE DETECTION UNIT
CAMERA STABILIZATION CONTROL UNIT
CAMERA COMMUNICATION CONTROL UNIT
SHUTTER CONTROL UNIT
IMAGE SIGNAL PROCESSING UNIT
EXPOSURE TIMING CONTROL UNIT
SUBJECT MOVEMENT AMOUNT DETECTION UNIT
CAMERA CONTROL UNIT
SUBJECT POSITION DETECTION UNIT
MOTION VECTOR DETECTION UNIT
DISPLAY UNIT
STORAGE MEDIUM
OPERATING UNIT

FIG. 2

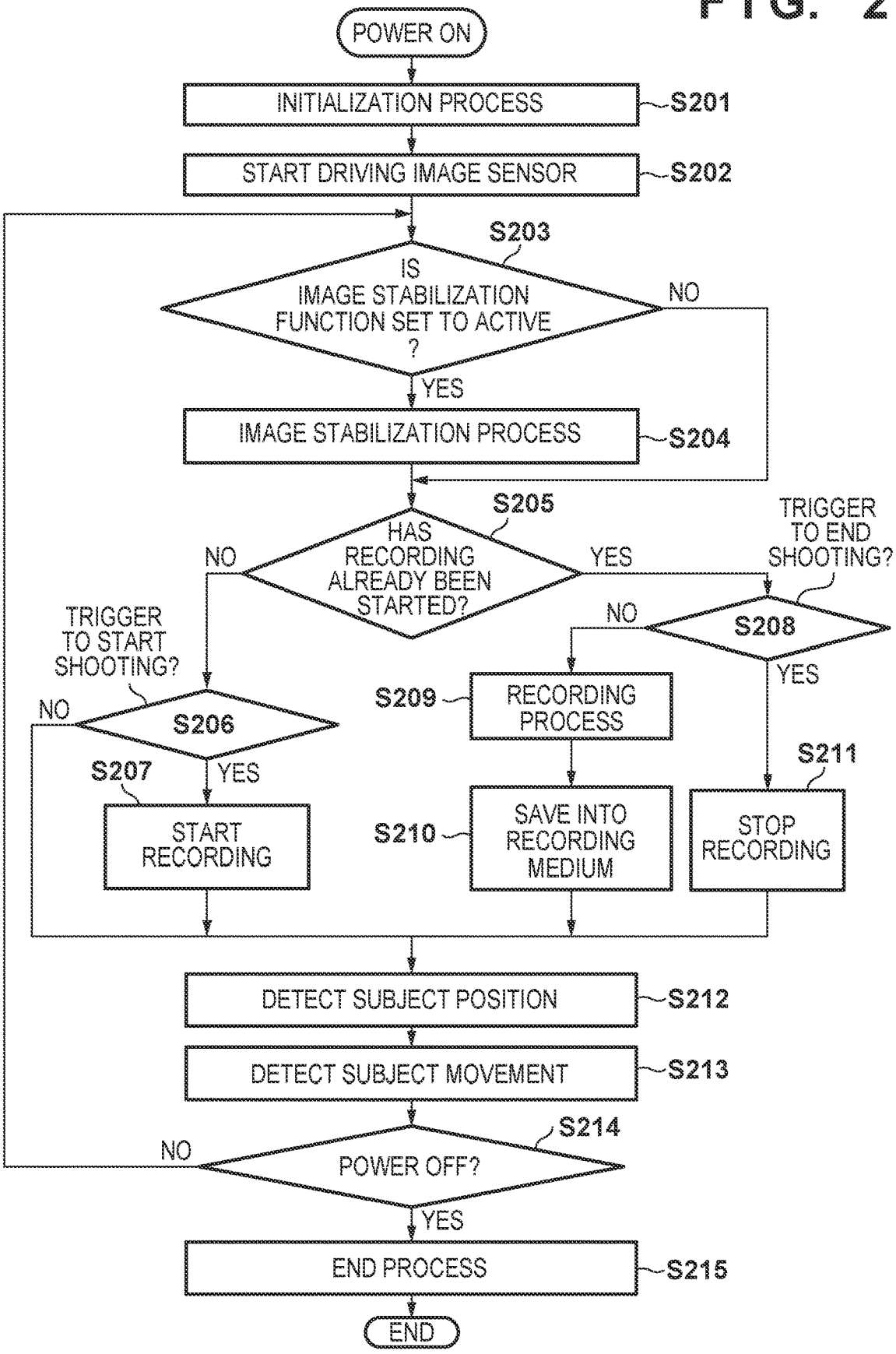
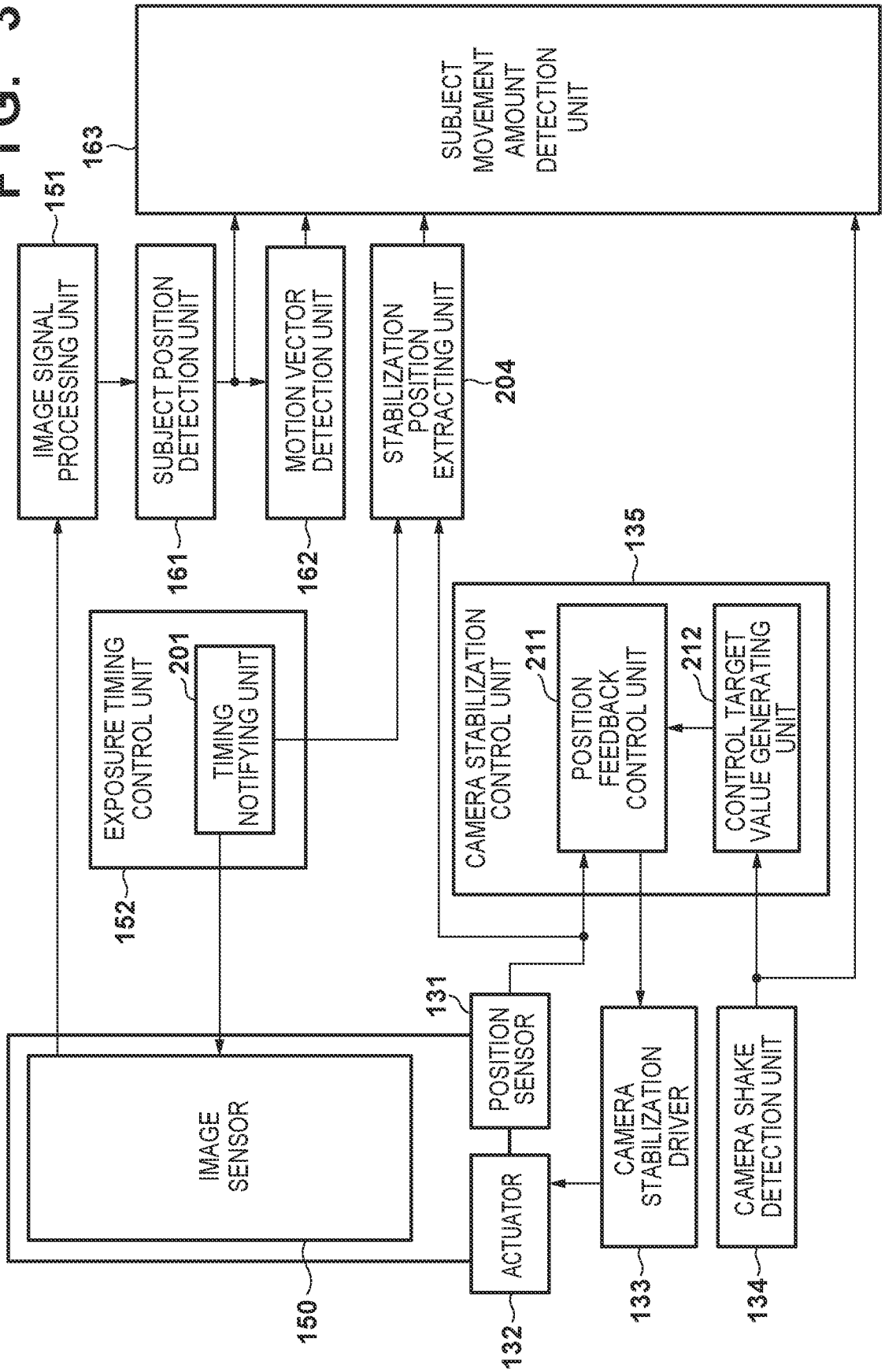

POWER ON
INITIALIZATION PROCESS
S201
START DRIVING IMAGE SENSOR
S202
S203
IS IMAGE STABILIZATION FUNCTION SET TO ACTIVE ?
NO
YES
IMAGE STABILIZATION PROCESS
S204
S205
HAS RECORDING ALREADY BEEN STARTED?
NO
YES
TRIGGER TO END SHOOTING?
NO
S208
YES
TRIGGER TO START SHOOTING?
NO
S206
YES
S209
RECORDING PROCESS
S211
S207
START RECORDING
S210
SAVE INTO RECORDING MEDIUM
STOP RECORDING
DETECT SUBJECT POSITION
S212
DETECT SUBJECT MOVEMENT
S213
S214
NO
POWER OFF?
YES
END PROCESS
S215
END

FIG. 3


SUBJECT MOVEMENT AMOUNT DETECTION UNIT
163
IMAGE SIGNAL PROCESSING UNIT
151
SUBJECT POSITION DETECTION UNIT
161
MOTION VECTOR DETECTION UNIT
162
STABILIZATION POSITION EXTRACTING UNIT
204
EXPOSURE TIMING CONTROL UNIT
201
TIMING NOTIFYING UNIT
152
CAMERA STABILIZATION CONTROL UNIT
135
211
POSITION FEEDBACK CONTROL UNIT
212
CONTROL TARGET VALUE GENERATING UNIT
131
POSITION SENSOR
IMAGE SENSOR
150
ACTUATOR
132
CAMERA STABILIZATION DRIVER
133
CAMERA SHAKE DETECTION UNIT
134

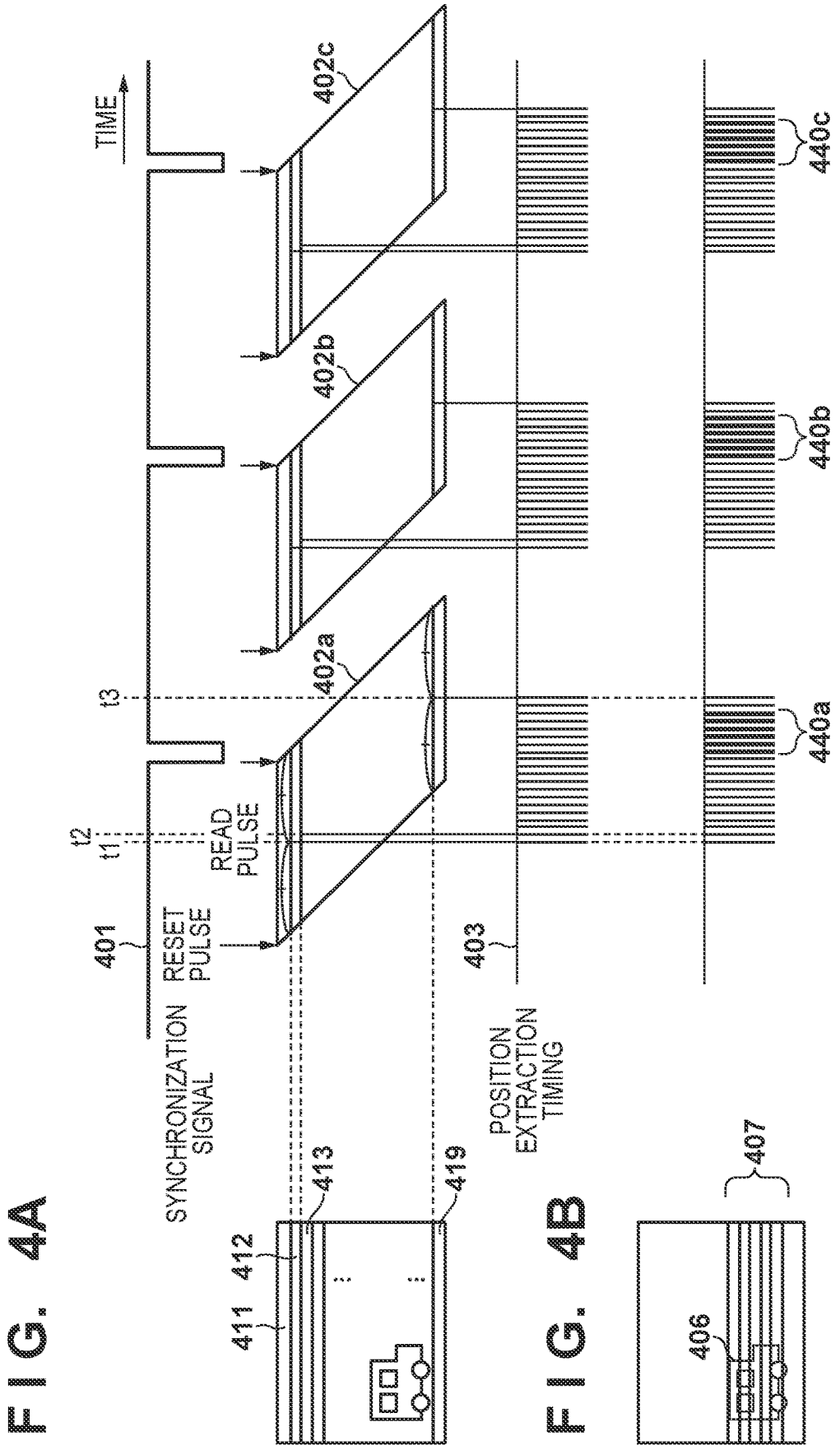

TIME
402c
402b
402a
t3
t2
t1
READ PULSE
RESET PULSE
401
403
440c
440b
440a
SYNCHRONIZATION SIGNAL
POSITION EXTRACTION TIMING
413
419
412
411
407
406

FIG. 4A

FIG. 4B

FIG. 5

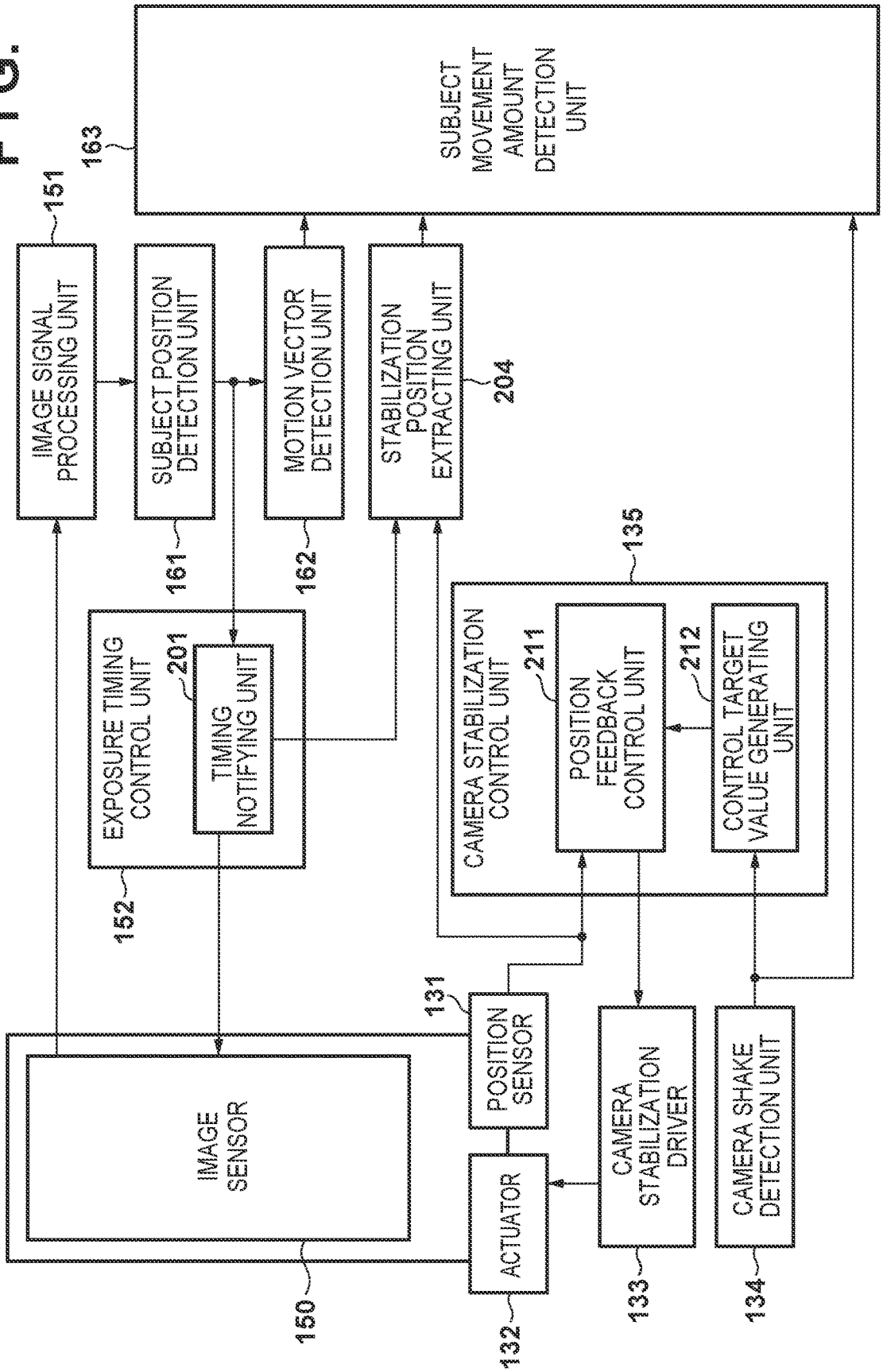

SUBJECT MOVEMENT AMOUNT DETECTION UNIT
163
151
IMAGE SIGNAL PROCESSING UNIT
SUBJECT POSITION DETECTION UNIT
161
MOTION VECTOR DETECTION UNIT
162
STABILIZATION POSITION EXTRACTING UNIT
204
EXPOSURE TIMING CONTROL UNIT
201
TIMING NOTIFYING UNIT
152
135
CAMERA STABILIZATION CONTROL UNIT
211
POSITION FEEDBACK CONTROL UNIT
212
CONTROL TARGET VALUE GENERATING UNIT
131
POSITION SENSOR
IMAGE SENSOR
ACTUATOR
CAMERA STABILIZATION DRIVER
CAMERA SHAKE DETECTION UNIT
150
132
133
134

FIG. 6

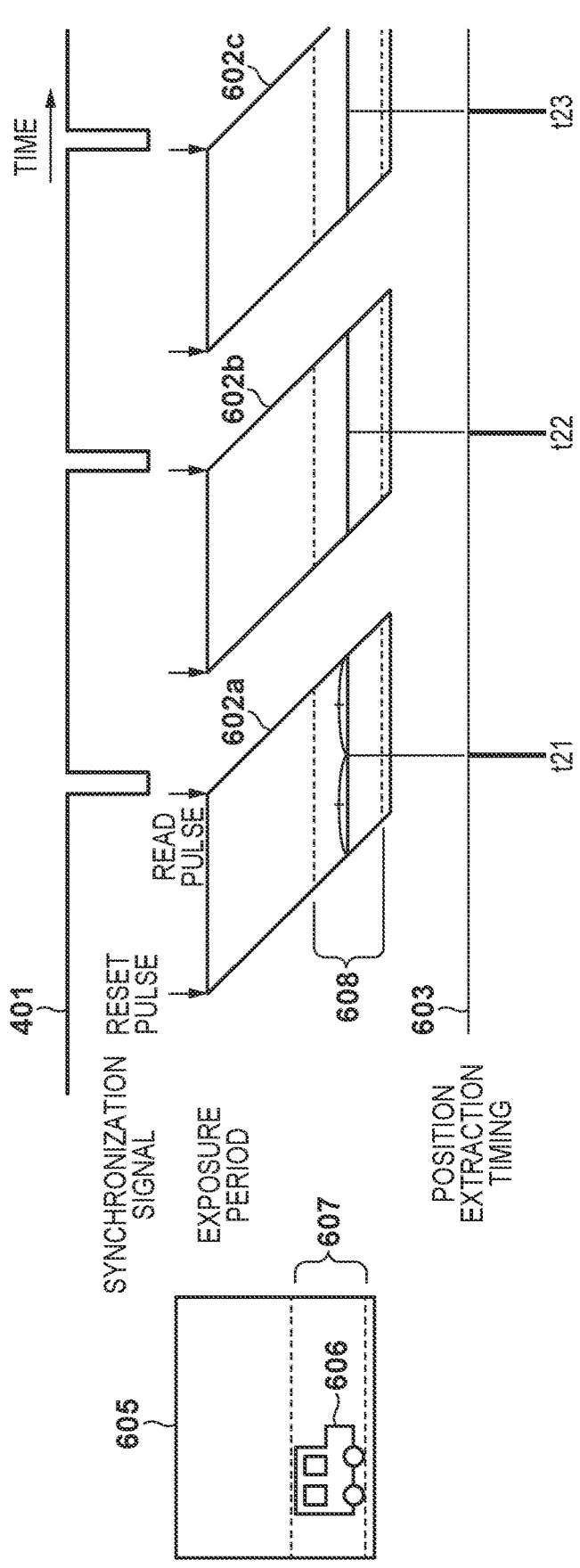

TIME
602c
602b
602a
t23
t22
t21
READ PULSE
RESET PULSE
401
608
603
SYNCHRONIZATION SIGNAL
EXPOSURE PERIOD
POSITION EXTRACTION TIMING
607
606
605

FIG. 7

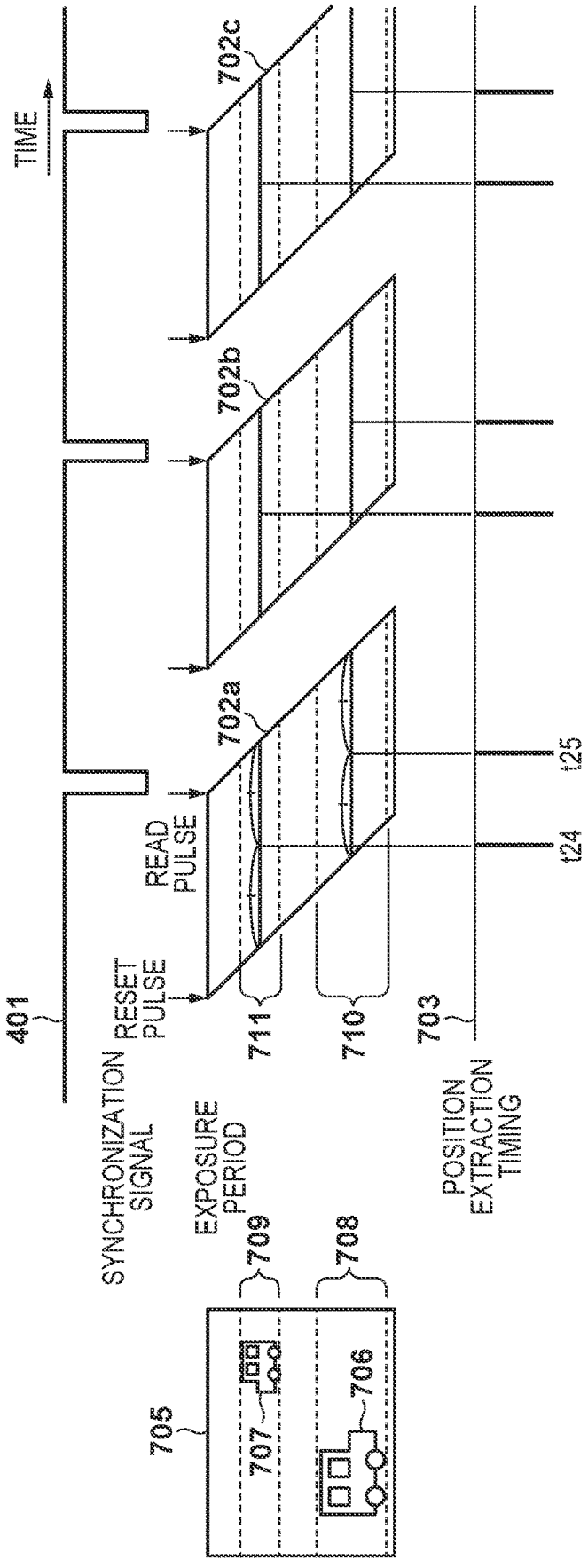

TIME
702c
702b
702a
READ PULSE
RESET PULSE
401
711
710
703
t25
t24
SYNCHRONIZATION SIGNAL
EXPOSURE PERIOD
709
708
POSITION EXTRACTION TIMING
705
707
706

FIG. 8

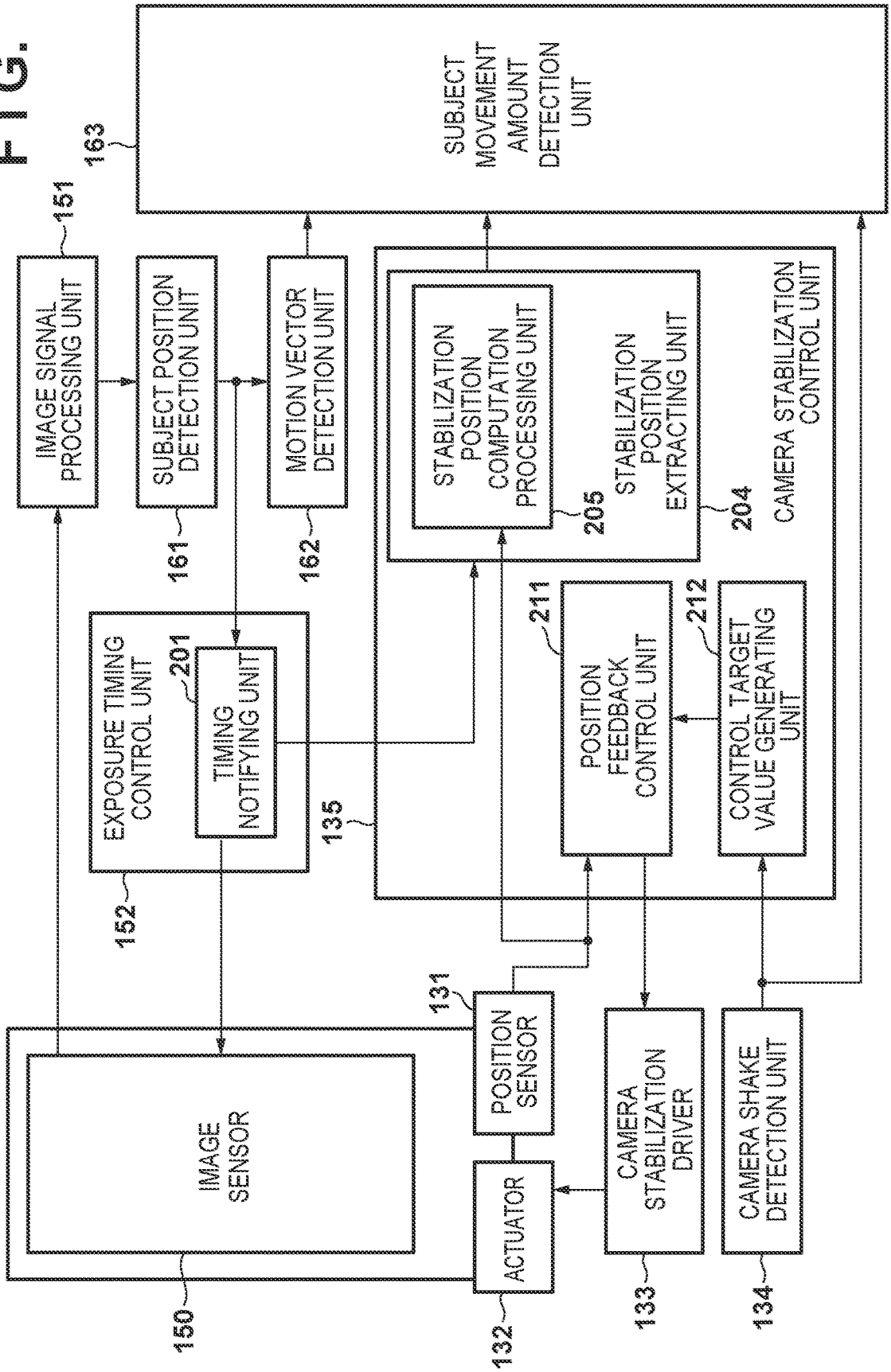

SUBJECT MOVEMENT AMOUNT DETECTION UNIT
163
IMAGE SIGNAL PROCESSING UNIT
151
SUBJECT POSITION DETECTION UNIT
161
MOTION VECTOR DETECTION UNIT
162
STABILIZATION POSITION COMPUTATION PROCESSING UNIT
205
STABILIZATION POSITION EXTRACTING UNIT
204
CAMERA STABILIZATION CONTROL UNIT
EXPOSURE TIMING CONTROL UNIT
201
TIMING NOTIFYING UNIT
152
135
211
POSITION FEEDBACK CONTROL UNIT
212
CONTROL TARGET VALUE GENERATING UNIT
131
POSITION SENSOR
IMAGE SENSOR
ACTUATOR
CAMERA STABILIZATION DRIVER
CAMERA SHAKE DETECTION UNIT
150
132
133
134

FIG. 9

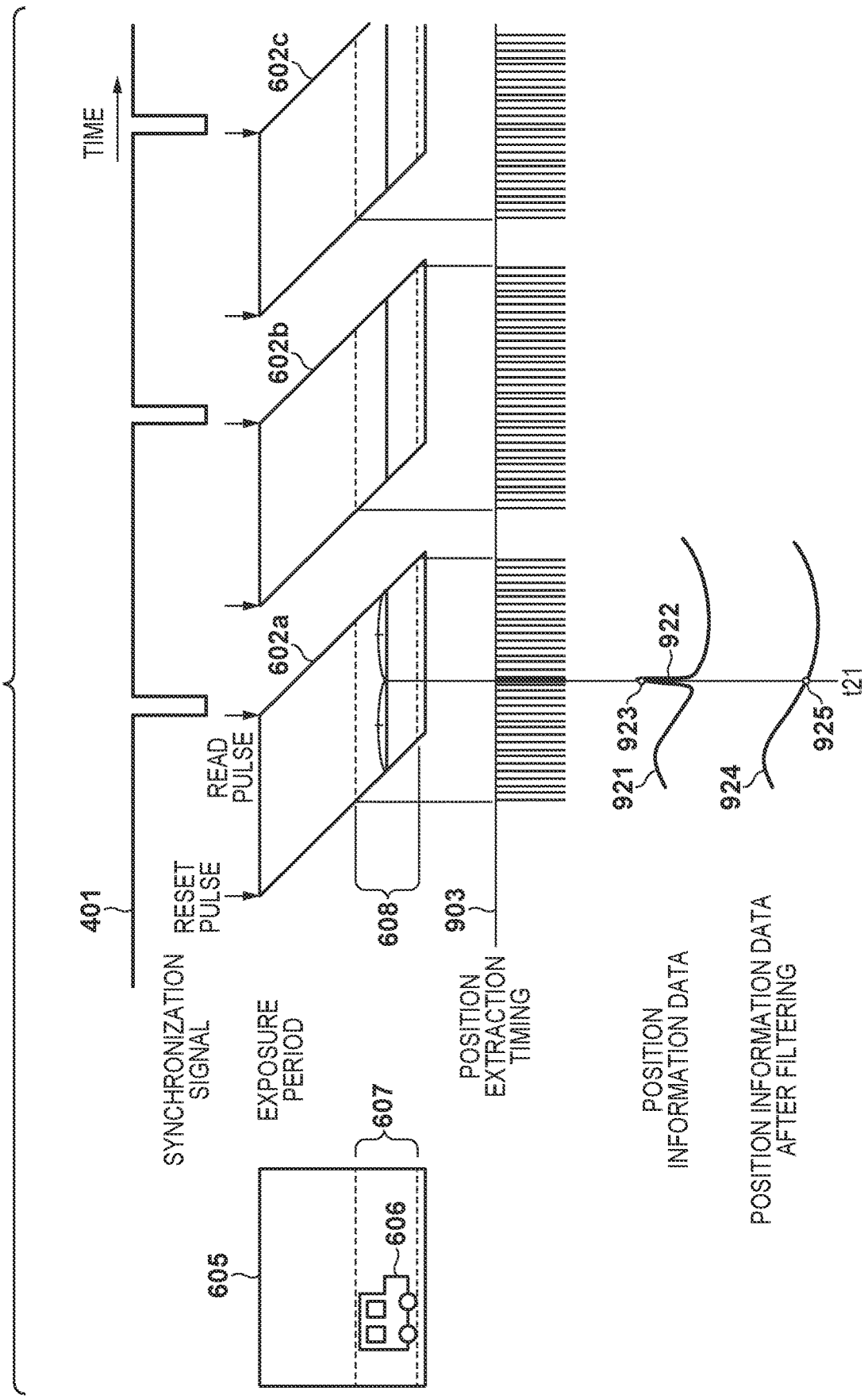

TIME
602c
602b
602a
READ PULSE
RESET PULSE
401
SYNCHRONIZATION SIGNAL
EXPOSURE PERIOD
607
605
606
608
903
POSITION EXTRACTION TIMING
921
923
922
924
925
t21
POSITION INFORMATION DATA
POSITION INFORMATION DATA AFTER FILTERING

FIG. 10

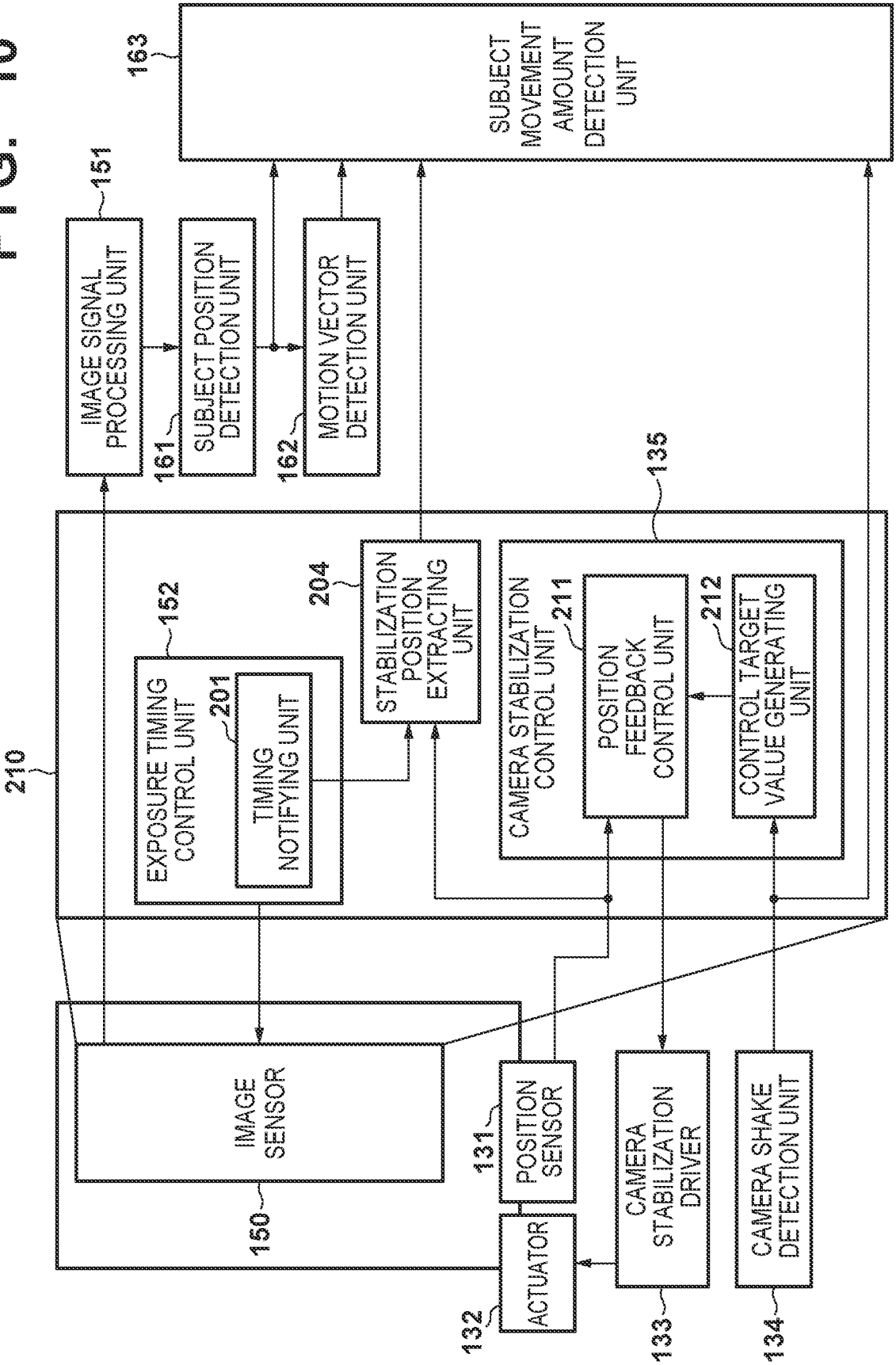
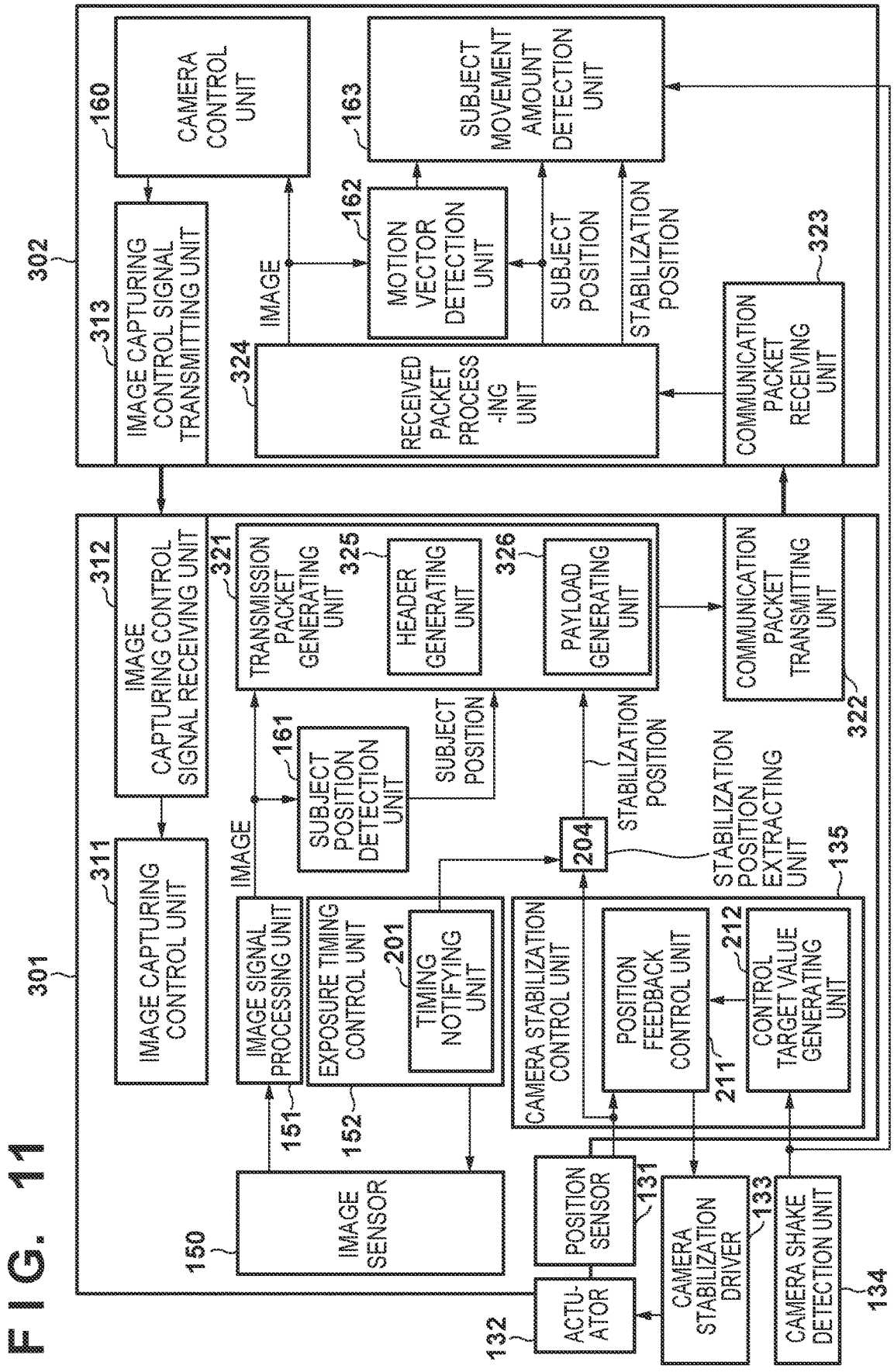

163
SUBJECT MOVEMENT AMOUNT DETECTION UNIT
151
IMAGE SIGNAL PROCESSING UNIT
161
SUBJECT POSITION DETECTION UNIT
162
MOTION VECTOR DETECTION UNIT
135
210
152
EXPOSURE TIMING CONTROL UNIT
201
TIMING NOTIFYING UNIT
204
STABILIZATION POSITION EXTRACTING UNIT
CAMERA STABILIZATION CONTROL UNIT
211
POSITION FEEDBACK CONTROL UNIT
212
CONTROL TARGET VALUE GENERATING UNIT
IMAGE SENSOR
150
131
POSITION SENSOR
ACTUATOR
132
CAMERA STABILIZATION DRIVER
133
CAMERA SHAKE DETECTION UNIT
134

FIG. 11


301
302
150
IMAGE SENSOR
151
152
IMAGE SIGNAL PROCESSING UNIT
EXPOSURE TIMING CONTROL UNIT
201
TIMING NOTIFYING UNIT
311
IMAGE CAPTURING CONTROL UNIT
312
IMAGE CAPTURING CONTROL SIGNAL RECEIVING UNIT
313
IMAGE CAPTURING CONTROL SIGNAL TRANSMITTING UNIT
IMAGE
161
SUBJECT POSITION DETECTION UNIT
SUBJECT POSITION
204
STABILIZATION POSITION
CAMERA STABILIZATION CONTROL UNIT
211
POSITION FEEDBACK CONTROL UNIT
212
CONTROL TARGET VALUE GENERATING UNIT
STABILIZATION POSITION EXTRACTING UNIT
135
321
TRANSMISSION PACKET GENERATING UNIT
325
HEADER GENERATING UNIT
326
PAYLOAD GENERATING UNIT
322
COMMUNICATION PACKET TRANSMITTING UNIT
160
CAMERA CONTROL UNIT
162
MOTION VECTOR DETECTION UNIT
163
SUBJECT MOVEMENT AMOUNT DETECTION UNIT
SUBJECT POSITION
STABILIZATION POSITION
324
RECEIVED PACKET PROCESS-ING UNIT
323
COMMUNICATION PACKET RECEIVING UNIT
131
POSITION SENSOR
132
ACTU-ATOR
133
CAMERA STABILIZATION DRIVER
134
CAMERA SHAKE DETECTION UNIT

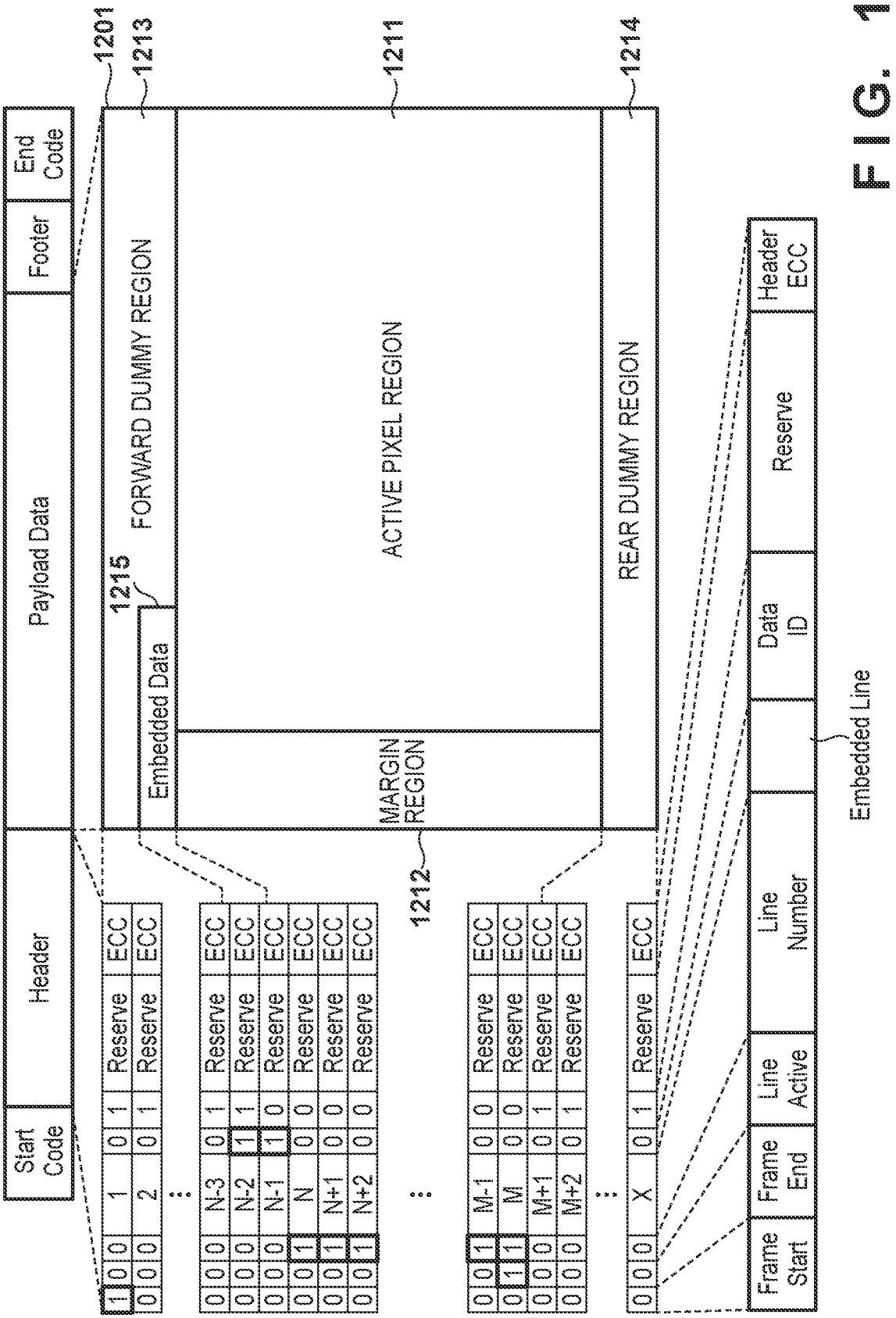

Start Code
Header
Payload Data
Footer
End Code
1201
1213
1211
1214
1215
1212
FORWARD DUMMY REGION
ACTIVE PIXEL REGION
REAR DUMMY REGION
Embedded Data
MARGIN REGION
Frame Start
Frame End
Line Active
Line Number
Data ID
Reserve
Header ECC
Embedded Line
Reserve
ECC
1
2
N-3
N-2
N-1
N
N+1
N+2
M-1
M
M+1
M+2
X

FIG. 12

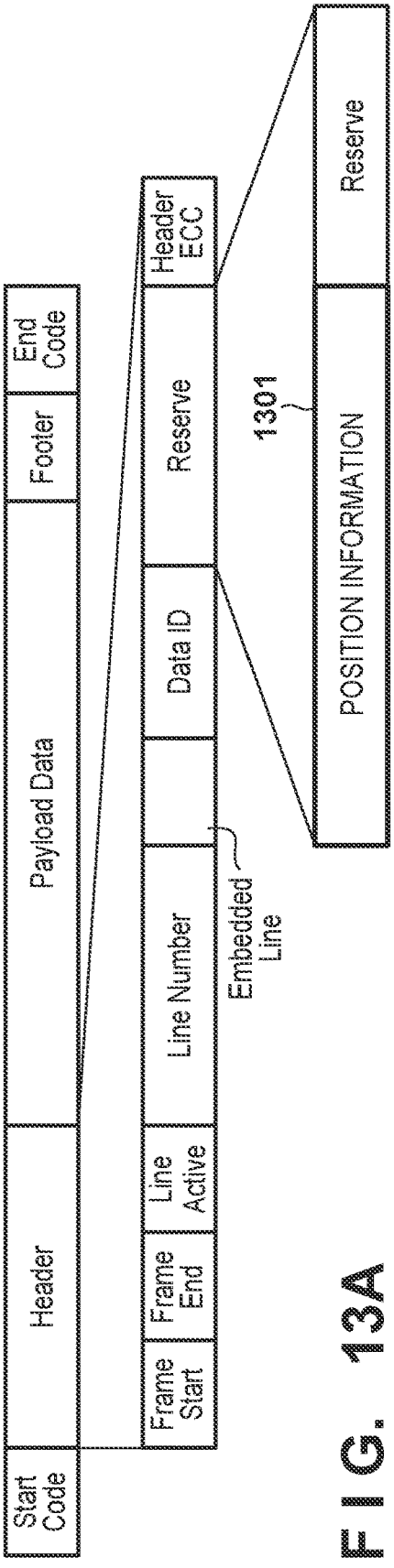


FIG. 13A

FIG. 13B

CLASSIFICATION	CLASSIFICATION	NUMBER OF BITS	CONTENT
FRAME INFORMATION	Frame Start	1bit	INDICATES LEADING DATA OF FRAME
	Frame End	1bit	INDICATES TERMINATING DATA OF FRAME (BECOMES 1 AT INITIAL REAR DUMMY LINE)
LINE INFORMATION	Line Active	1bit	INDICATES WHETHER LINE IS ACTIVE/INACTIVE
	Line Number	13bit	INDICATES LINE NUMBER
	Embedded Line	1bit	INDICATES EMBEDDED LINE NUMBER
DATA INFORMATION	Data ID	2bit	INDICATES DATA IDENTIFICATION
OTHER	POSITION INFORMATION	24bit	INDICATES POSITION INFORMATION OF IMAGE STABILIZATION MECHANISM
	Reserve	5bit	INDICATES EXTENSION REGION
	Header ECC	18bit	ECC OF HEADER INFORMATION

FIG. 13C

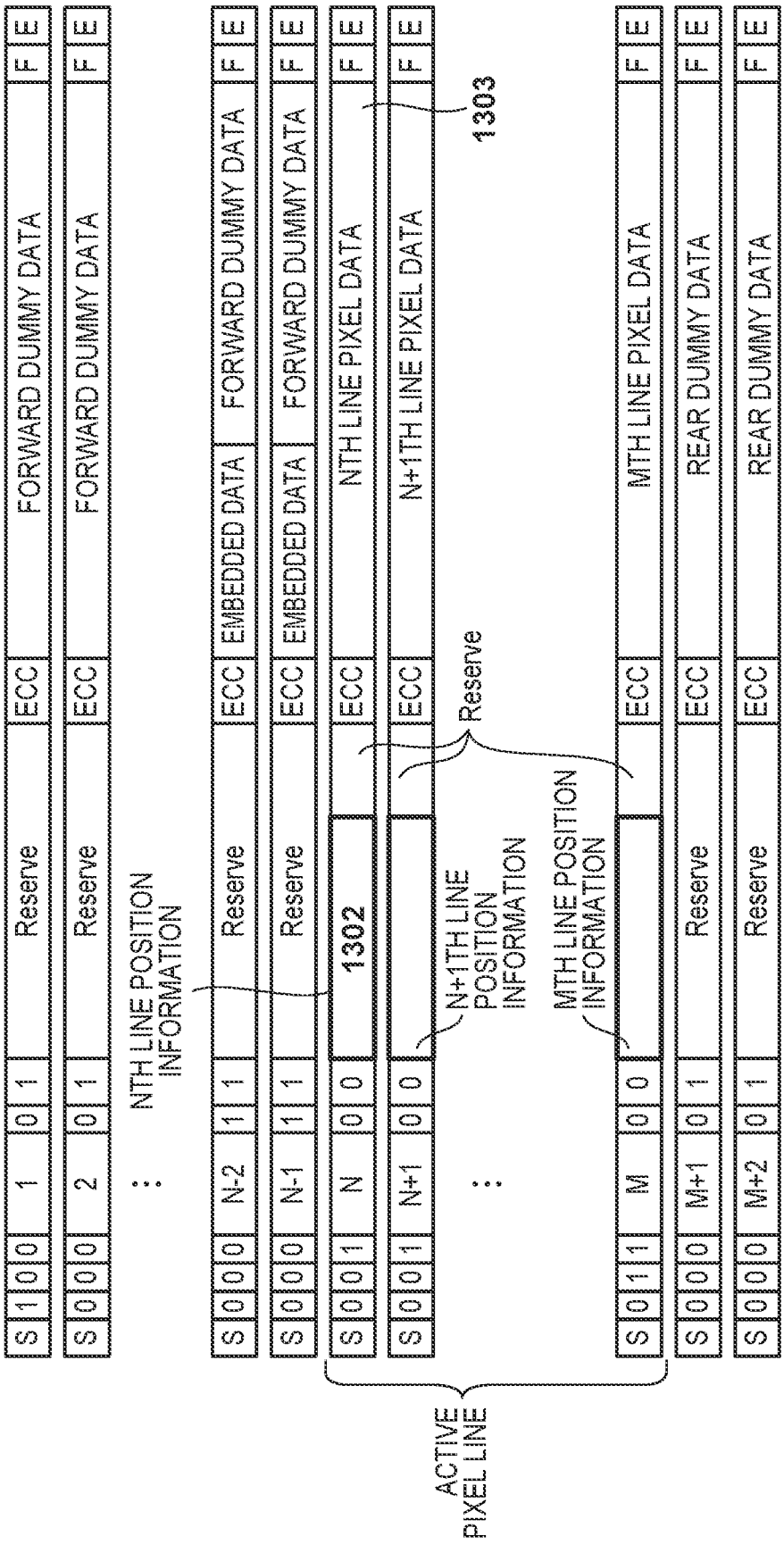

S 1 0 0 | 1 | 0 1 | Reserve | ECC | FORWARD DUMMY DATA | F E
S 0 0 0 | 2 | 0 1 | Reserve | ECC | FORWARD DUMMY DATA | F E
NTH LINE POSITION INFORMATION
S 0 0 0 | N-2 | 1 1 | Reserve | ECC | EMBEDDED DATA | FORWARD DUMMY DATA | F E
S 0 0 0 | N-1 | 1 1 | Reserve | ECC | EMBEDDED DATA | FORWARD DUMMY DATA | F E
S 0 0 1 | N | 0 0 | 1302 | ECC | NTH LINE PIXEL DATA | F E
S 0 0 1 | N+1 | 0 0 | ECC | N+1TH LINE PIXEL DATA | F E
1303
Reserve
N+1TH LINE POSITION INFORMATION
MTH LINE POSITION INFORMATION
S 0 1 1 | M | 0 0 | ECC | MTH LINE PIXEL DATA | F E
S 0 0 0 | M+1 | 0 1 | Reserve | ECC | REAR DUMMY DATA | F E
S 0 0 0 | M+2 | 0 1 | Reserve | ECC | REAR DUMMY DATA | F E
ACTIVE PIXEL LINE

FIG. 14A

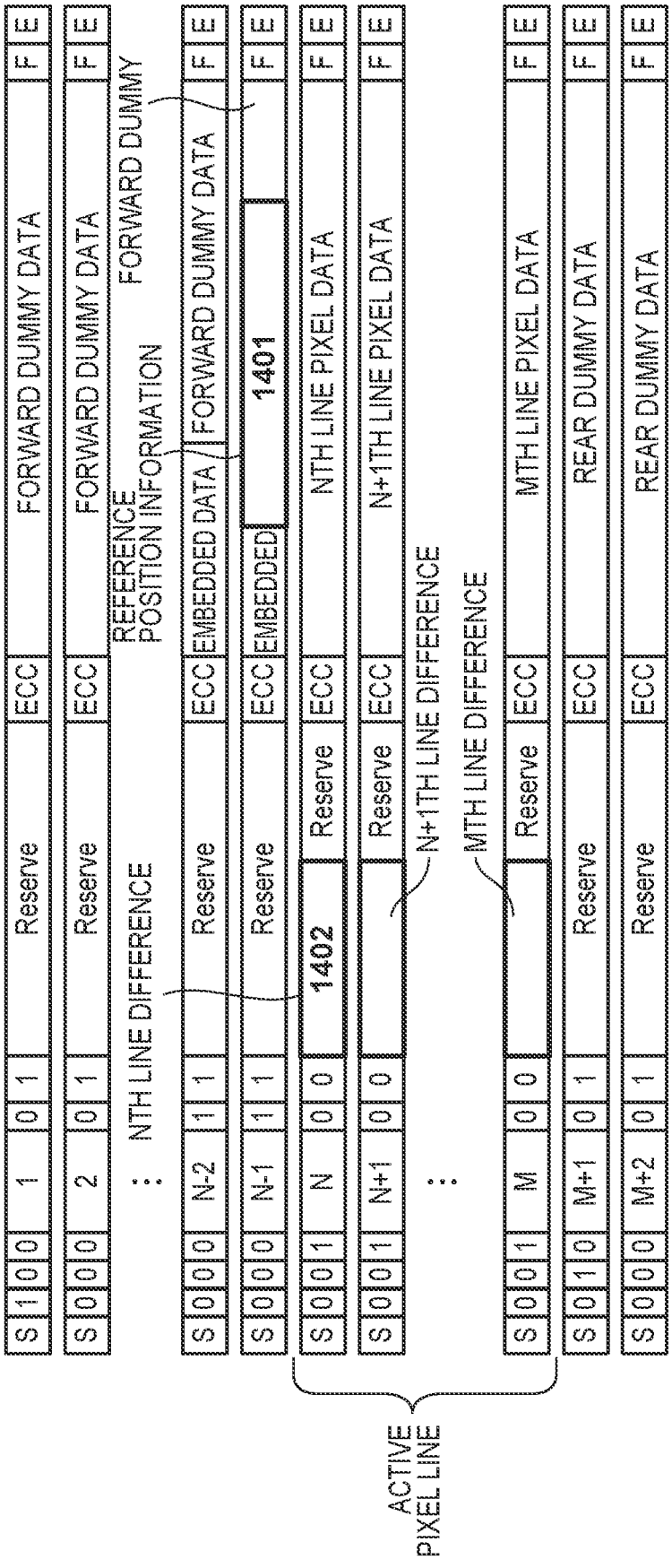

S 1 0 0 1 0 1 Reserve ECC FORWARD DUMMY DATA F E
S 0 0 0 2 0 1 Reserve ECC FORWARD DUMMY DATA F E
REFERENCE POSITION INFORMATION
FORWARD DUMMY
: NTH LINE DIFFERENCE
S 0 0 0 N-2 1 1 Reserve ECC EMBEDDED DATA FORWARD DUMMY DATA F E
S 0 0 0 N-1 1 1 Reserve ECC EMBEDDED 1401 F E
S 0 0 1 N 0 0 1402 Reserve ECC NTH LINE PIXEL DATA F E
S 0 0 1 N+1 0 0 Reserve ECC N+1TH LINE PIXEL DATA F E
N+1TH LINE DIFFERENCE
MTH LINE DIFFERENCE
S 0 0 1 M 0 0 Reserve ECC MTH LINE PIXEL DATA F E
S 0 1 0 M+1 0 1 Reserve ECC REAR DUMMY DATA F E
S 0 0 0 M+2 0 1 Reserve ECC REAR DUMMY DATA F E
ACTIVE PIXEL LINE

FIG. 14B

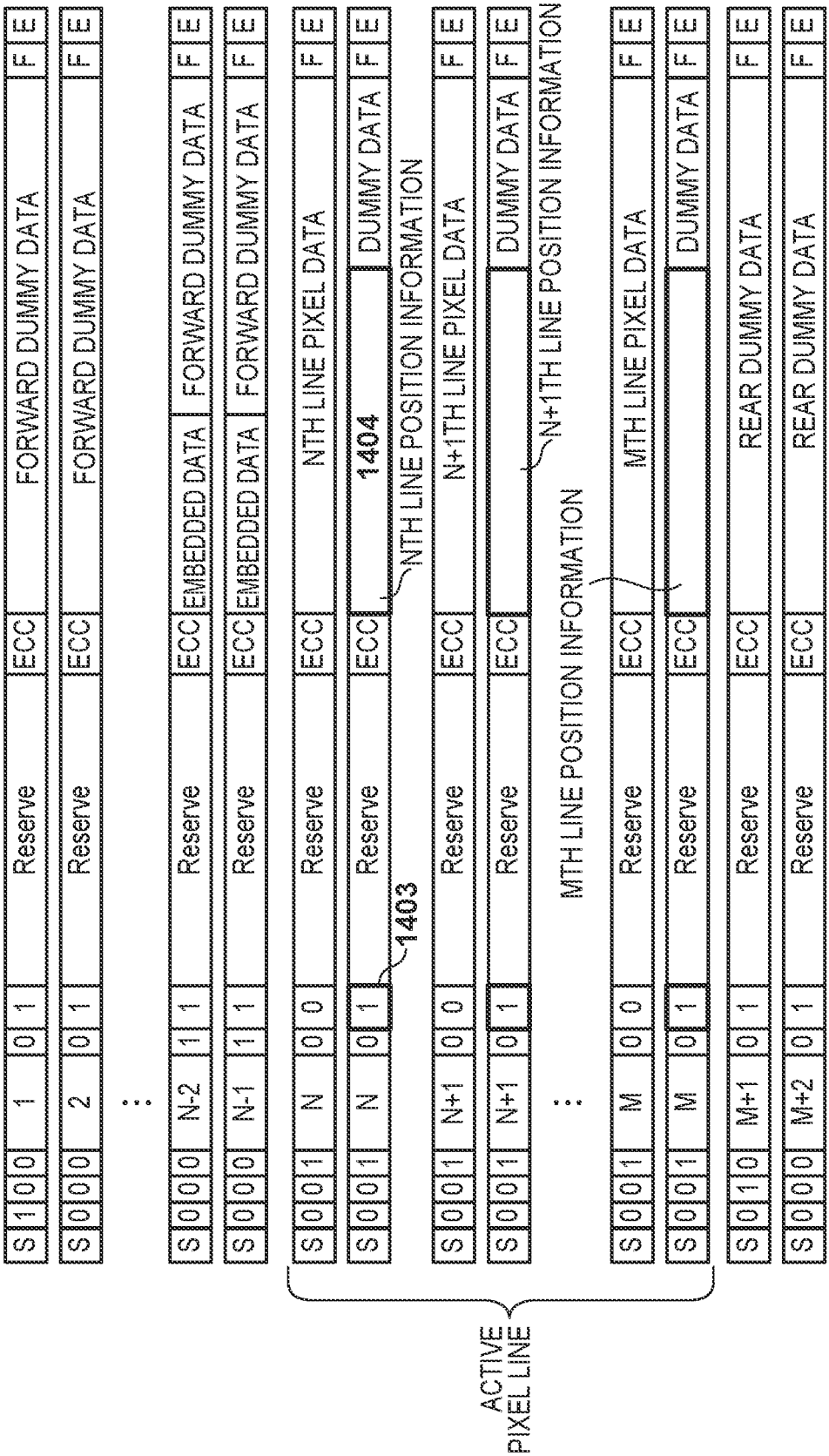

S 1 0 0 1 0 1 Reserve ECC FORWARD DUMMY DATA F E
S 0 0 0 2 0 1 Reserve ECC FORWARD DUMMY DATA F E
S 0 0 0 N-2 1 1 Reserve ECC EMBEDDED DATA FORWARD DUMMY DATA F E
S 0 0 0 N-1 1 1 Reserve ECC EMBEDDED DATA FORWARD DUMMY DATA F E
S 0 0 1 N 0 0 Reserve ECC NTH LINE PIXEL DATA F E
S 0 0 1 N 0 1 Reserve ECC 1404 DUMMY DATA F E
1403
NTH LINE POSITION INFORMATION
S 0 0 1 N+1 0 0 Reserve ECC N+1TH LINE PIXEL DATA F E
S 0 0 1 N+1 0 1 Reserve ECC DUMMY DATA F E
N+1TH LINE POSITION INFORMATION
MTH LINE POSITION INFORMATION
S 0 0 1 M 0 0 Reserve ECC MTH LINE PIXEL DATA F E
S 0 0 1 M 0 1 Reserve ECC DUMMY DATA F E
S 0 1 0 M+1 0 1 Reserve ECC REAR DUMMY DATA F E
S 0 0 0 M+2 0 1 Reserve ECC REAR DUMMY DATA F E
ACTIVE PIXEL LINE

FIG. 14C

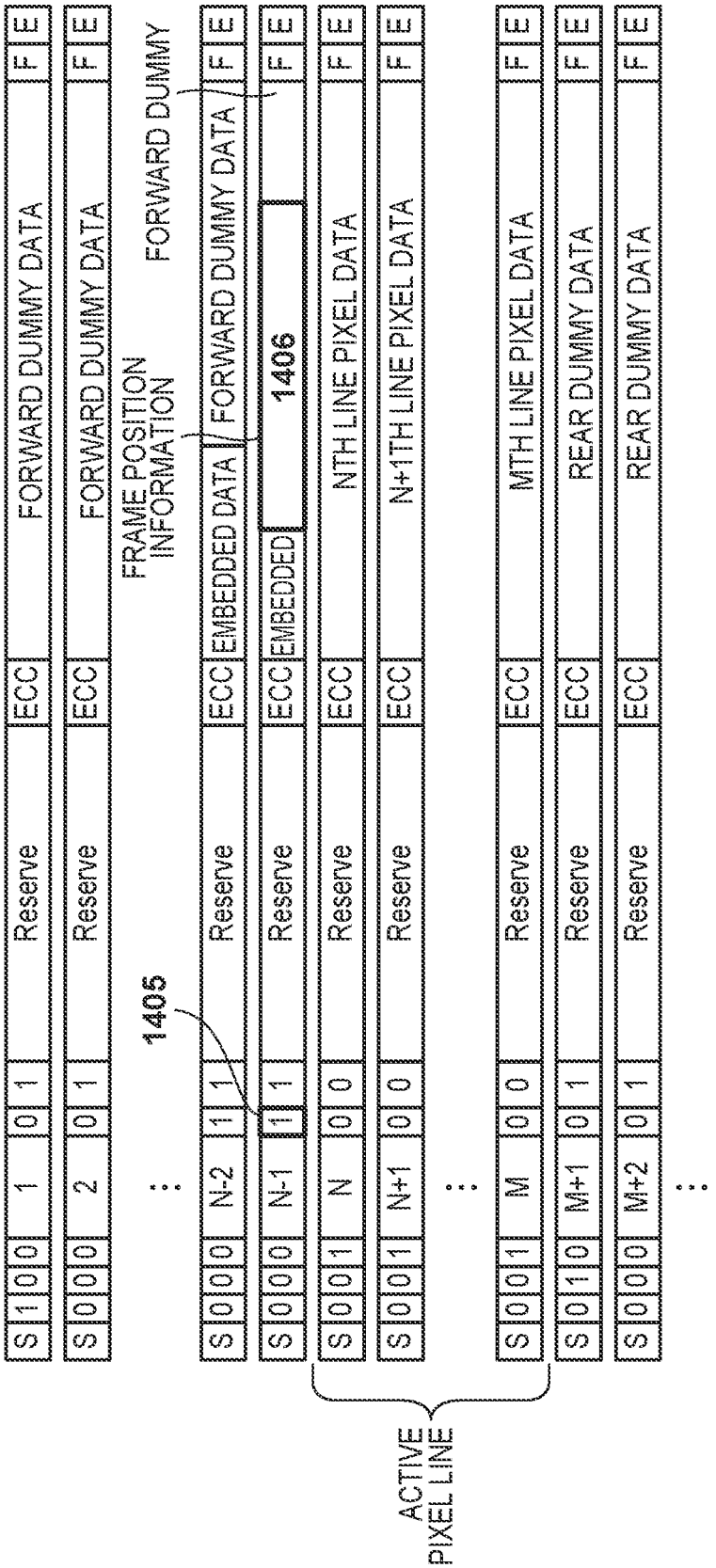

S 1 0 0 1 0 1 Reserve ECC FORWARD DUMMY DATA F E
S 0 0 0 2 0 1 Reserve ECC FORWARD DUMMY DATA F E
1405
FRAME POSITION INFORMATION
FORWARD DUMMY
S 0 0 0 N-2 1 1 Reserve ECC EMBEDDED DATA FORWARD DUMMY DATA F E
S 0 0 0 N-1 1 1 Reserve ECC EMBEDDED 1406 F E
S 0 0 1 N 0 0 Reserve ECC NTH LINE PIXEL DATA F E
S 0 0 1 N+1 0 0 Reserve ECC N+1TH LINE PIXEL DATA F E
S 0 0 1 M 0 0 Reserve ECC MTH LINE PIXEL DATA F E
S 0 1 0 M+1 0 1 Reserve ECC REAR DUMMY DATA F E
S 0 0 0 M+2 0 1 Reserve ECC REAR DUMMY DATA F E
ACTIVE PIXEL LINE

FIG. 15

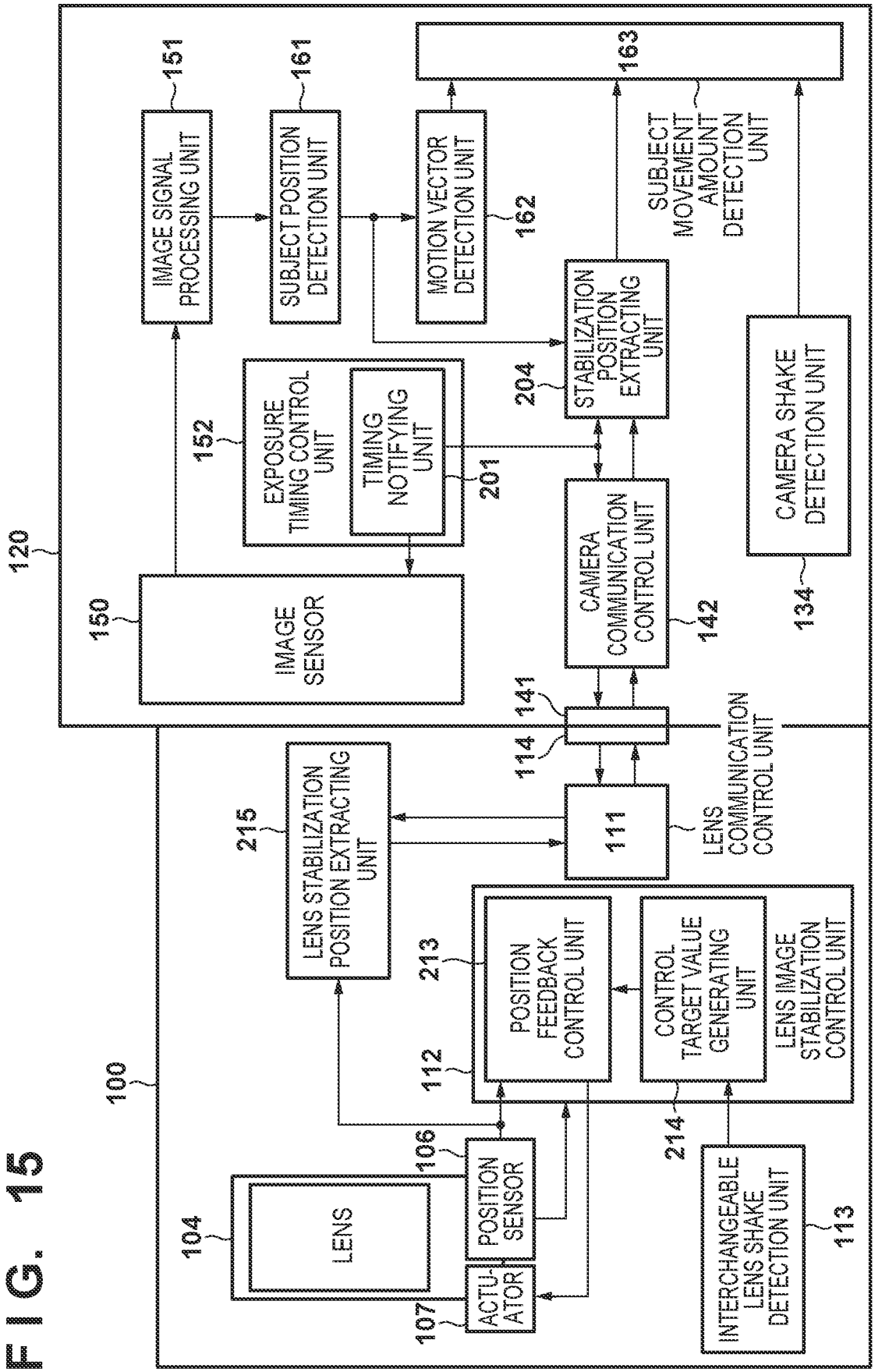

100
120
150
IMAGE SENSOR
152
EXPOSURE TIMING CONTROL UNIT
TIMING NOTIFYING UNIT
201
151
IMAGE SIGNAL PROCESSING UNIT
161
SUBJECT POSITION DETECTION UNIT
MOTION VECTOR DETECTION UNIT
162
163
SUBJECT MOVEMENT AMOUNT DETECTION UNIT
204
STABILIZATION POSITION EXTRACTING UNIT
CAMERA COMMUNICATION CONTROL UNIT
142
CAMERA SHAKE DETECTION UNIT
134
141
114
LENS COMMUNICATION CONTROL UNIT
111
215
LENS STABILIZATION POSITION EXTRACTING UNIT
213
POSITION FEEDBACK CONTROL UNIT
CONTROL TARGET VALUE GENERATING UNIT
LENS IMAGE STABILIZATION CONTROL UNIT
112
214
104
LENS
106
POSITION SENSOR
107
ACTU-ATOR
INTERCHANGEABLE LENS SHAKE DETECTION UNIT
113

FIG. 16

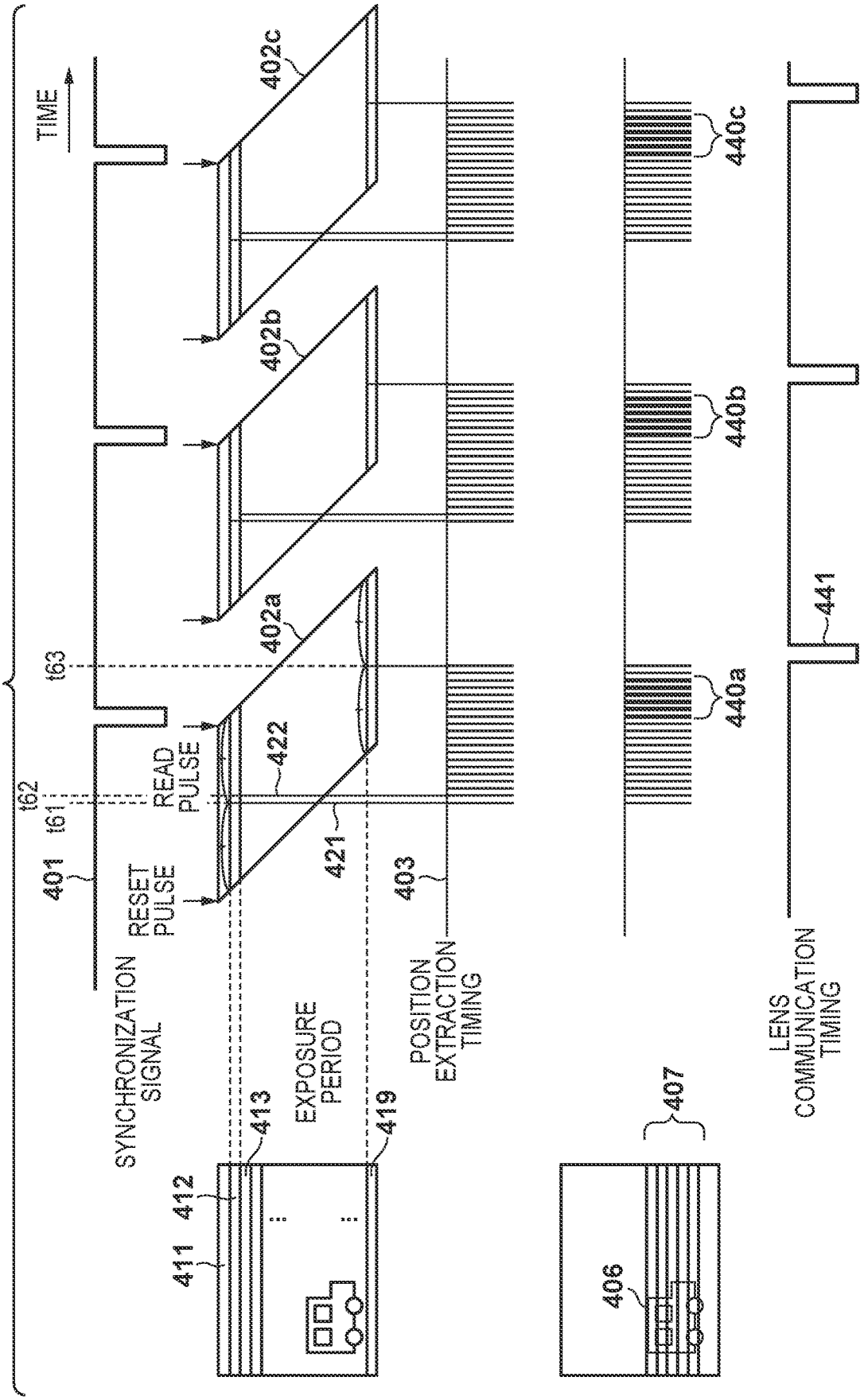

TIME
402c
402b
402a
t63
t62
t61
READ PULSE
RESET PULSE
422
421
401
403
SYNCHRONIZATION SIGNAL
EXPOSURE PERIOD
POSITION EXTRACTION TIMING
413
419
412
411
406
407
440c
440b
440a
441
LENS COMMUNICATION TIMING

FIG. 17

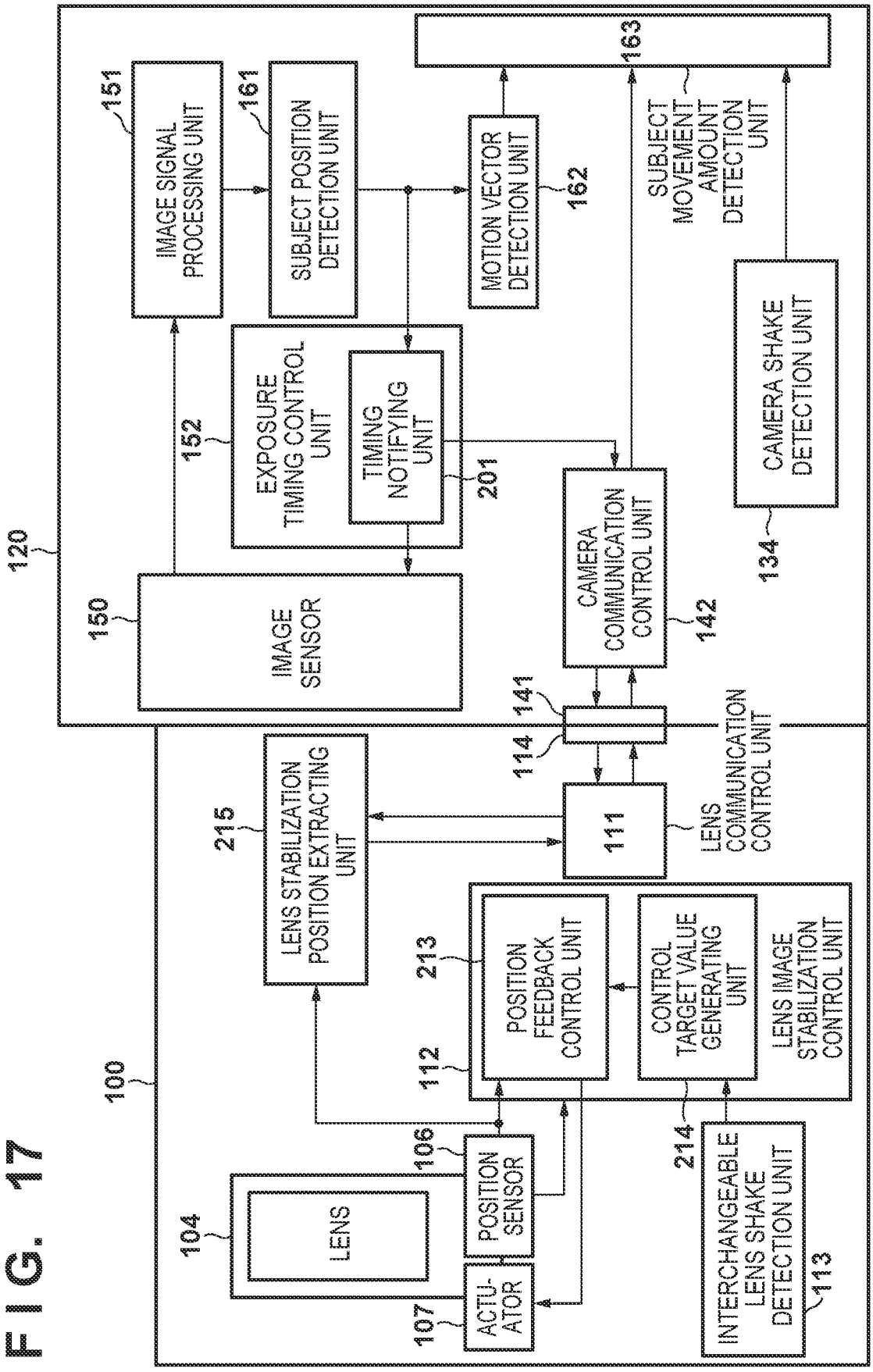

100
120
104
LENS
106
POSITION SENSOR
107
ACTU-ATOR
112
213
POSITION FEEDBACK CONTROL UNIT
214
CONTROL TARGET VALUE GENERATING UNIT
LENS IMAGE STABILIZATION CONTROL UNIT
INTERCHANGEABLE LENS SHAKE DETECTION UNIT
113
215
LENS STABILIZATION POSITION EXTRACTING UNIT
111
LENS COMMUNICATION CONTROL UNIT
114
141
CAMERA COMMUNICATION CONTROL UNIT
142
150
IMAGE SENSOR
152
EXPOSURE TIMING CONTROL UNIT
TIMING NOTIFYING UNIT
201
151
IMAGE SIGNAL PROCESSING UNIT
161
SUBJECT POSITION DETECTION UNIT
MOTION VECTOR DETECTION UNIT
162
163
SUBJECT MOVEMENT AMOUNT DETECTION UNIT
CAMERA SHAKE DETECTION UNIT
134

FIG. 18

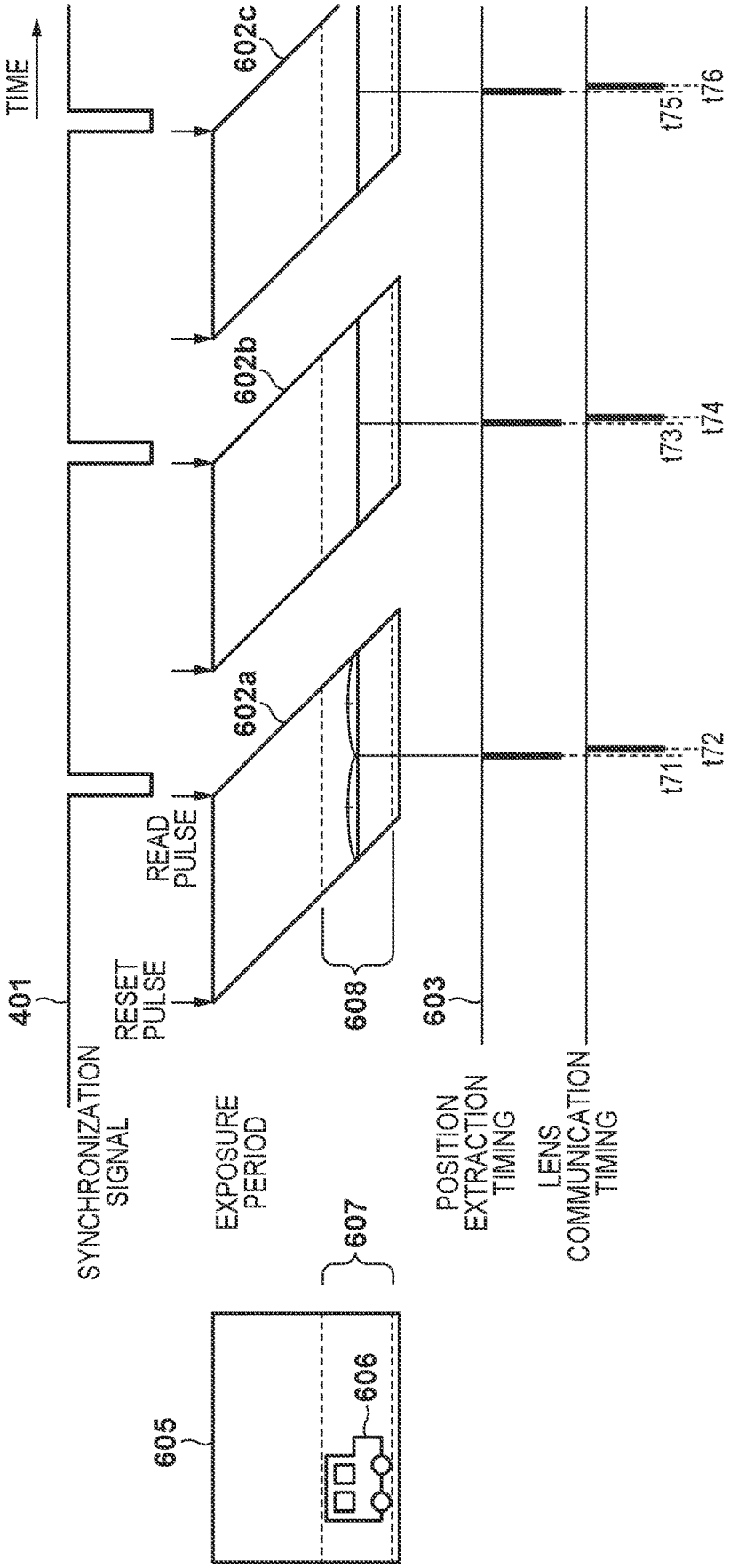

TIME
602c
602b
602a
READ PULSE
RESET PULSE
401
SYNCHRONIZATION SIGNAL
608
603
EXPOSURE PERIOD
607
POSITION EXTRACTION TIMING
LENS COMMUNICATION TIMING
605
606
t71
t72
t73
t74
t75
t76

FIG. 19

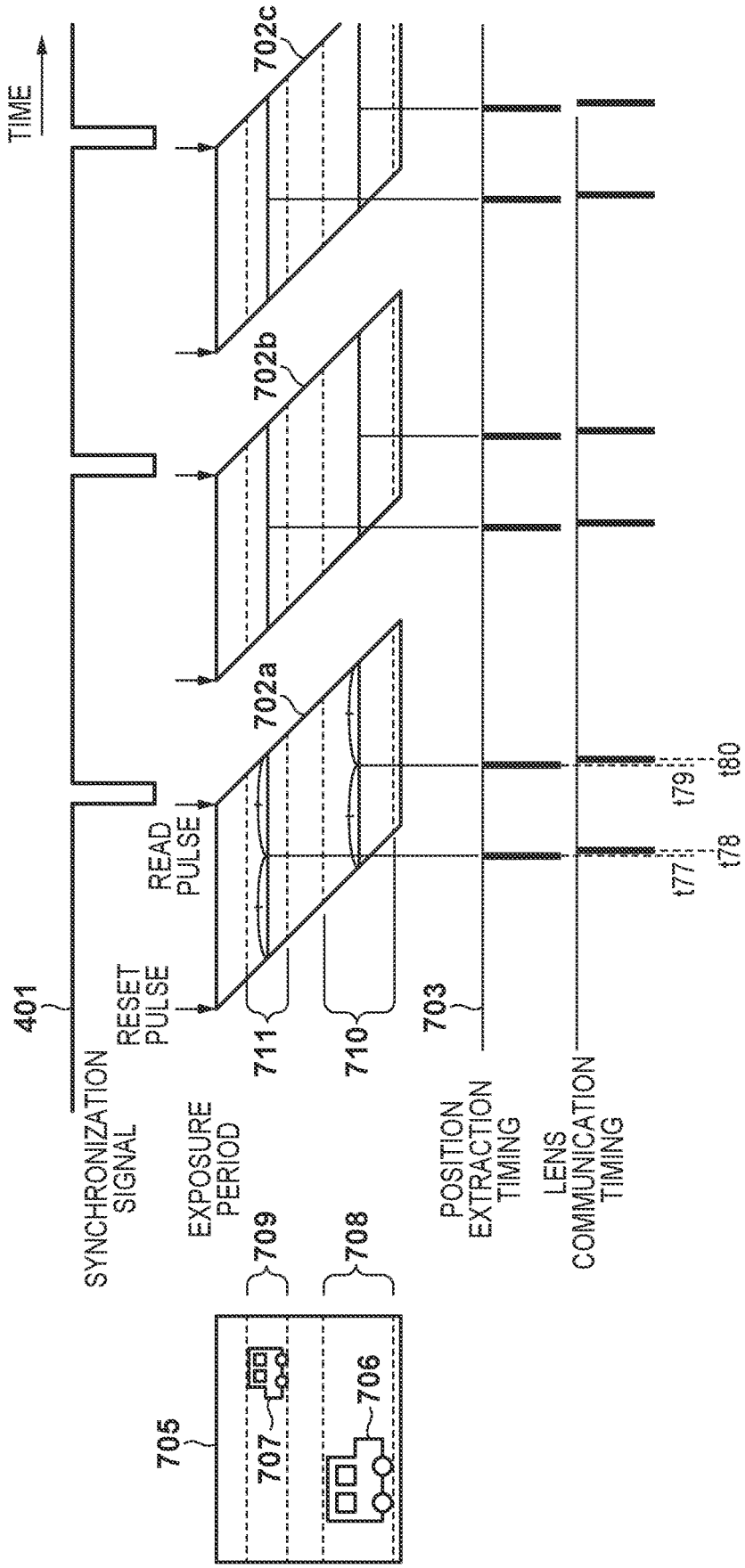

TIME
702c
702b
702a
READ PULSE
RESET PULSE
401
SYNCHRONIZATION SIGNAL
EXPOSURE PERIOD
711
710
703
POSITION EXTRACTION TIMING
LENS COMMUNICATION TIMING
709
708
705
707
706
t77
t78
t79
t80

FIG. 20

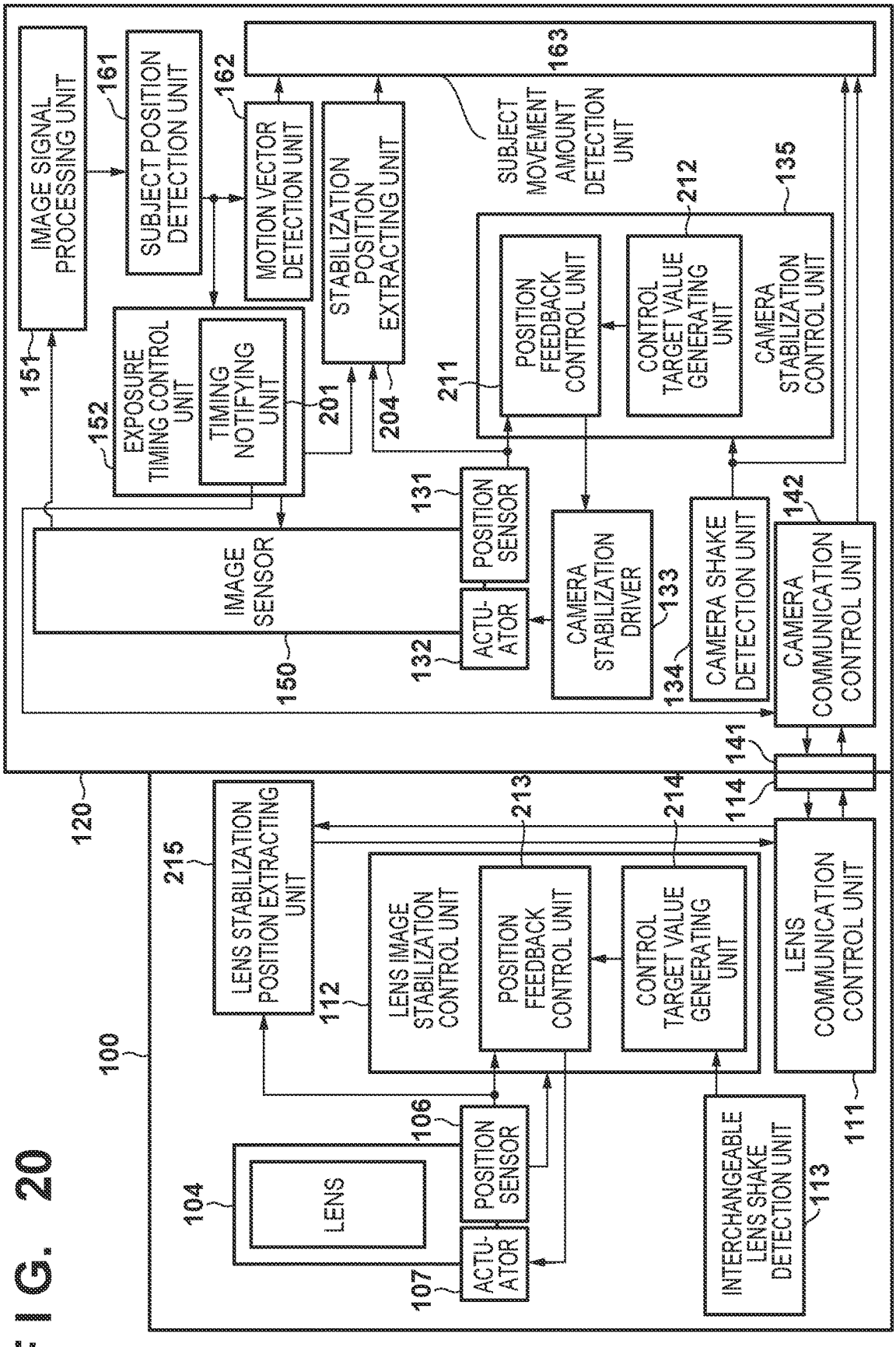

100
120
IMAGE SIGNAL PROCESSING UNIT
151
SUBJECT POSITION DETECTION UNIT
161
MOTION VECTOR DETECTION UNIT
162
SUBJECT MOVEMENT AMOUNT DETECTION UNIT
163
EXPOSURE TIMING CONTROL UNIT
152
TIMING NOTIFYING UNIT
201
STABILIZATION POSITION EXTRACTING UNIT
204
211
POSITION FEEDBACK CONTROL UNIT
CONTROL TARGET VALUE GENERATING UNIT
212
CAMERA STABILIZATION CONTROL UNIT
135
IMAGE SENSOR
150
POSITION SENSOR
131
ACTU-ATOR
132
CAMERA STABILIZATION DRIVER
133
CAMERA SHAKE DETECTION UNIT
134
CAMERA COMMUNICATION CONTROL UNIT
142
141
114
LENS STABILIZATION POSITION EXTRACTING UNIT
215
LENS IMAGE STABILIZATION CONTROL UNIT
112
213
214
LENS
104
POSITION SENSOR
106
ACTU-ATOR
107
INTERCHANGEABLE LENS SHAKE DETECTION UNIT
113
LENS COMMUNICATION CONTROL UNIT
111

FIG. 21

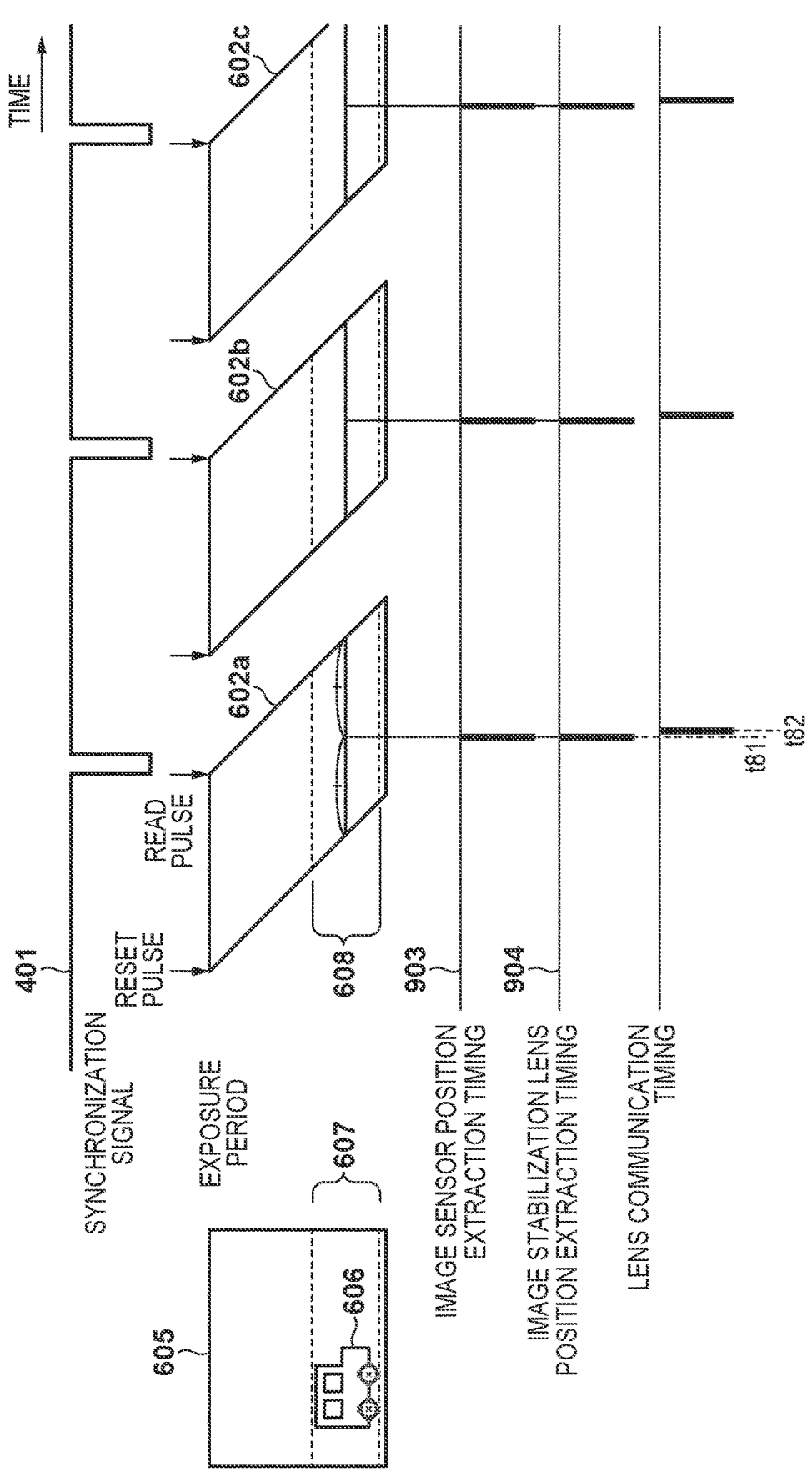

TIME
602c
602b
602a
READ PULSE
RESET PULSE
401
SYNCHRONIZATION SIGNAL
EXPOSURE PERIOD
608
607
605
606
903
IMAGE SENSOR POSITION EXTRACTION TIMING
904
IMAGE STABILIZATION LENS POSITION EXTRACTION TIMING
LENS COMMUNICATION TIMING
t81
t82

FIG. 22

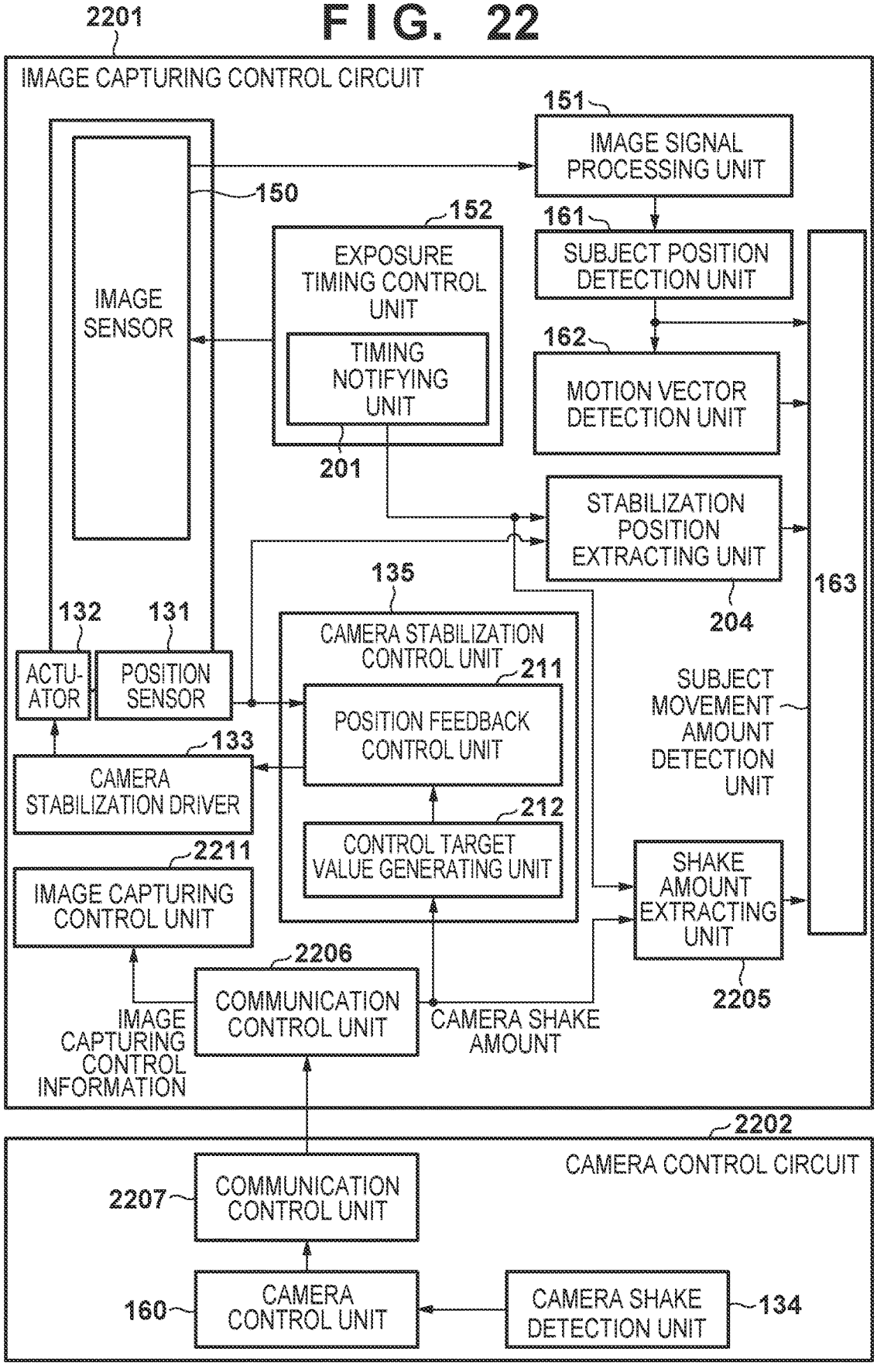

2201
IMAGE CAPTURING CONTROL CIRCUIT
151
IMAGE SIGNAL PROCESSING UNIT
150
IMAGE SENSOR
152
EXPOSURE TIMING CONTROL UNIT
TIMING NOTIFYING UNIT
201
161
SUBJECT POSITION DETECTION UNIT
162
MOTION VECTOR DETECTION UNIT
STABILIZATION POSITION EXTRACTING UNIT
204
163
135
CAMERA STABILIZATION CONTROL UNIT
211
POSITION FEEDBACK CONTROL UNIT
212
CONTROL TARGET VALUE GENERATING UNIT
132
131
ACTU-ATOR
POSITION SENSOR
133
CAMERA STABILIZATION DRIVER
2211
IMAGE CAPTURING CONTROL UNIT
SUBJECT MOVEMENT AMOUNT DETECTION UNIT
SHAKE AMOUNT EXTRACTING UNIT
2205
2206
COMMUNICATION CONTROL UNIT
IMAGE CAPTURING CONTROL INFORMATION
CAMERA SHAKE AMOUNT
2202
CAMERA CONTROL CIRCUIT
2207
COMMUNICATION CONTROL UNIT
160
CAMERA CONTROL UNIT
CAMERA SHAKE DETECTION UNIT
134

FIG. 23

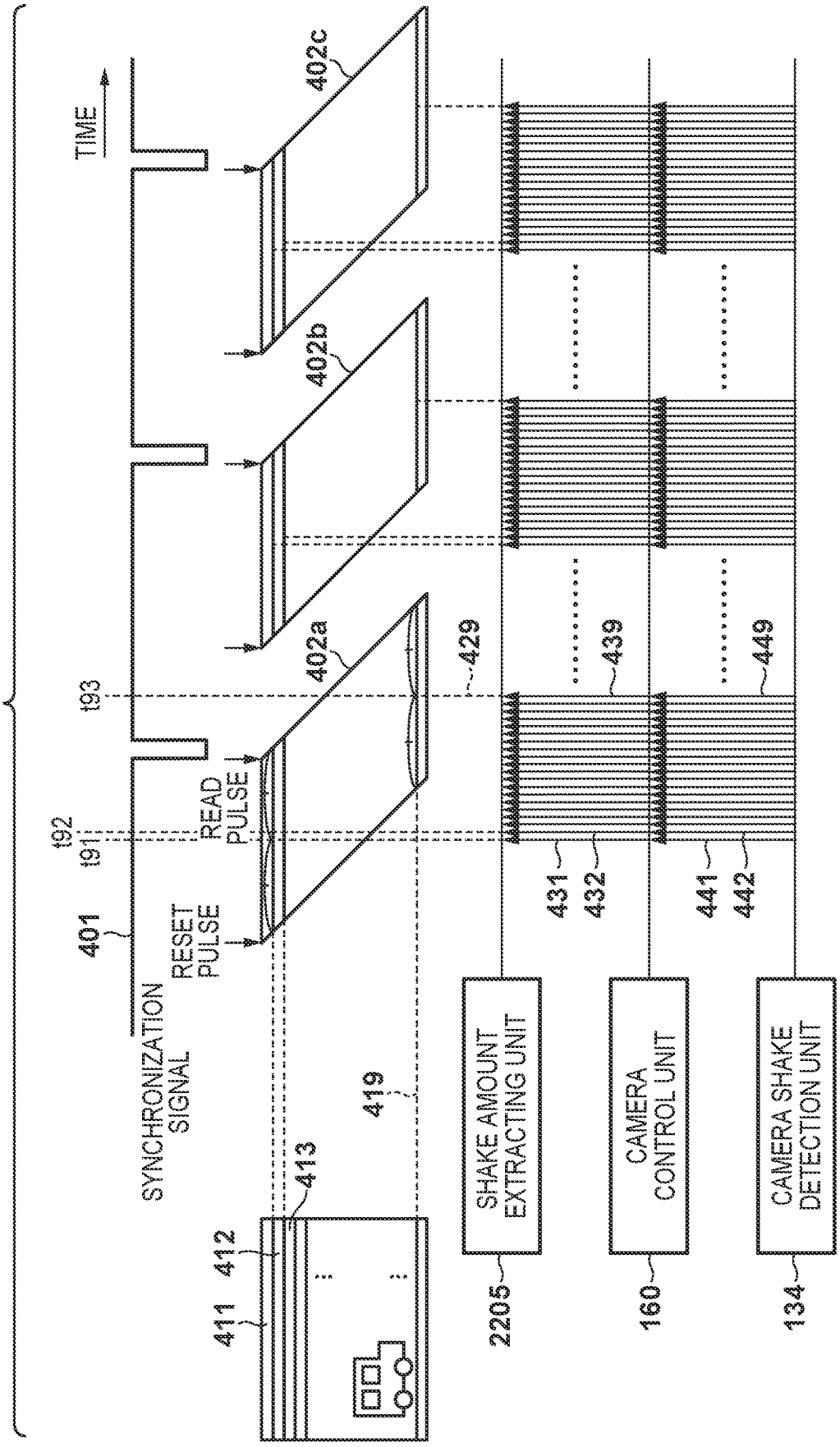

TIME
402c
402b
402a
429
439
449
t93
t92
t91
READ PULSE
RESET PULSE
401
SYNCHRONIZATION SIGNAL
431
432
441
442
419
413
411
412
SHAKE AMOUNT EXTRACTING UNIT
CAMERA CONTROL UNIT
CAMERA SHAKE DETECTION UNIT
2205
160
134

FIG. 24

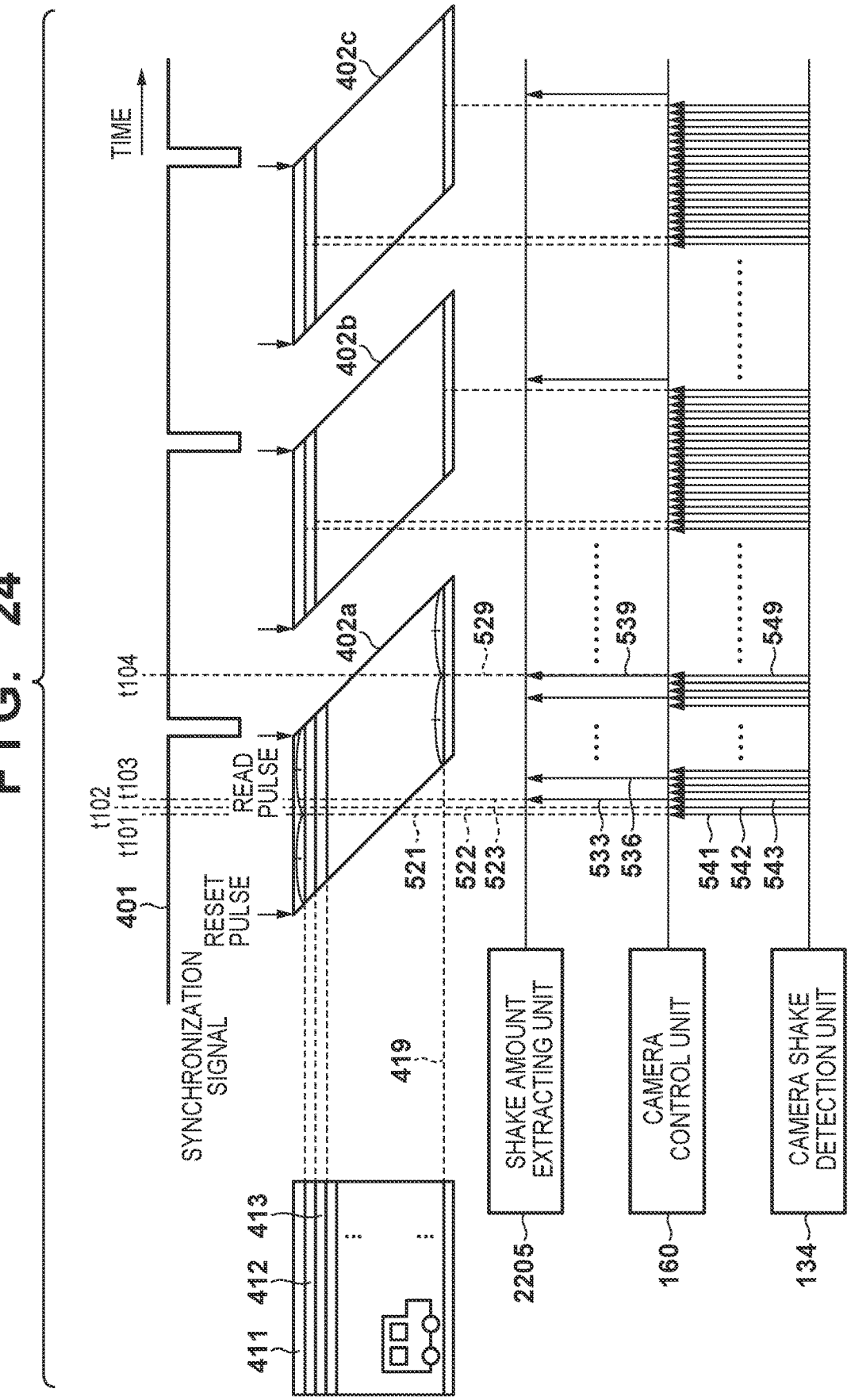

TIME
402c
402b
402a
t104
t1102
t1101
t1103
READ PULSE
RESET PULSE
SYNCHRONIZATION SIGNAL
401
529
539
549
521
522
523
533
536
541
542
543
419
411
412
413
SHAKE AMOUNT EXTRACTING UNIT
2205
CAMERA CONTROL UNIT
160
CAMERA SHAKE DETECTION UNIT
134

FIG. 25A

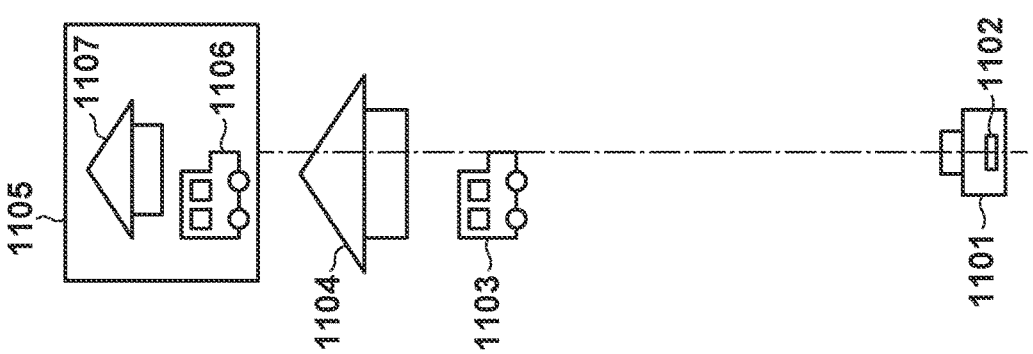


FIG. 25B

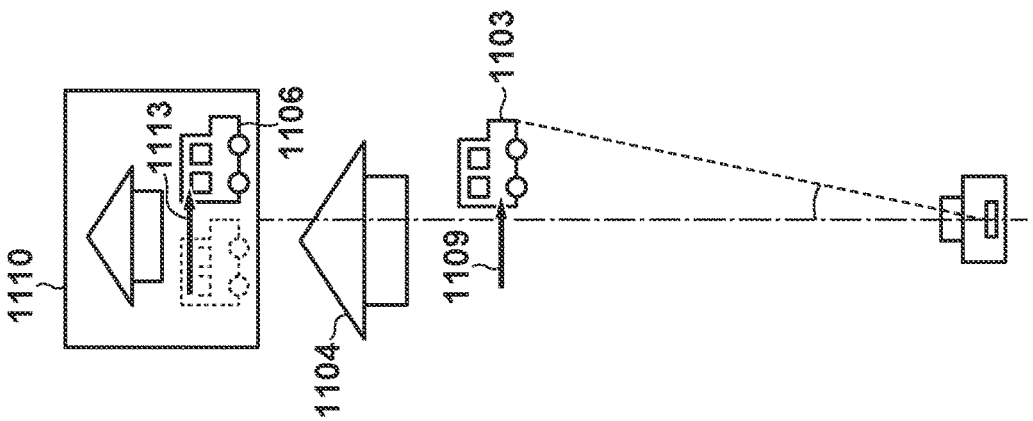


FIG. 25C

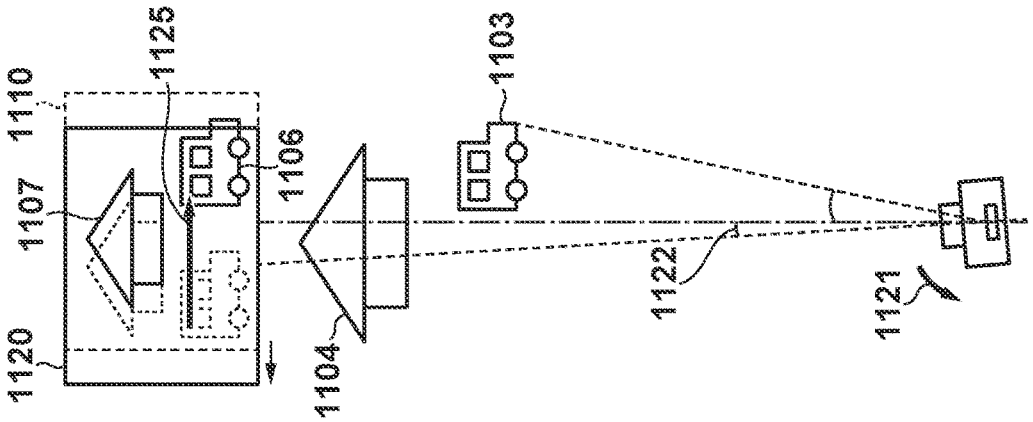


FIG. 25D

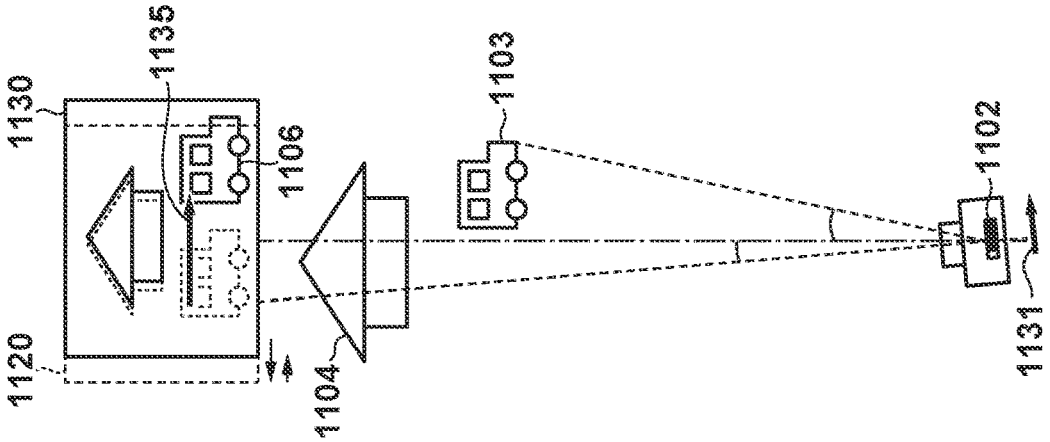


IMAGE STABILIZING APPARATUS, IMAGE PROCESSING APPARATUS, AND DETECTION METHOD

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to an image stabilizing apparatus, an image processing apparatus, and a detection method.

Description of the Related Art

[0002] Image capturing apparatuses, interchangeable lenses, and the like are known that have functions for detecting shake in the image capturing apparatus and correcting image blur caused by that shake using a movable optical lens or a movable image sensor. A function that corrects image blur using this method ("image stabilization function" hereinafter) is called "optical image stabilization". An angular velocity sensor (a gyrosensor), an accelerometer, or the like are typically used to detect shake in the image capturing apparatus, and the optical lens or the image sensor is driven, on the basis of a detected angular velocity or acceleration, in a direction that cancels out the image blur.

[0003] Recent years have seen increased framerates in image capturing apparatuses and advancements in image processing technologies. It is now possible to analyze difference between the positions of frame images and detect movement (a movement amount) of a subject by calculating a motion vector from the difference. An image stabilization function that cancels out image blur by changing the cutout position of each frame in a moving image on the basis of a movement amount detected in this manner is also known. This type of image stabilization function is called "electronic image stabilization". Electronic image stabilization is used in compact, lightweight image capturing apparatuses, mobile phones including image capturing apparatuses, and the like.

[0004] An image capturing apparatus can realize a variety of functions, including electronic image stabilization, by using information of the movement amount of a subject found from motion vectors. For example, moving body detection shooting, subject tracking autofocus, and the like can be realized. In moving body detection shooting, whether or not a subject is a moving body is detected, and the shutter speed, sensitivity, and the like are adjusted on the basis thereof. In subject tracking autofocus, the position of a subject is estimated from the movement amount of the subject, and the subject is brought into focus while being tracked. An automatic framing function, which shoots while automatically keeping a subject at a set size within the angle of view, and a panning shooting assist function, which helps make it easier to use the advanced shooting technique of panning shooting, can also be realized. Accurately calculating the movement amount of the subject is essential in order to effectively and accurately realize these various functions.

[0005] Japanese Patent Laid-Open No. 2015-161730 discloses a method for more accurately finding shake in an image capturing apparatus, by setting the timing at which shake is detected in the image capturing apparatus to between the exposure periods of two frames, in order to make panning shooting easier. The document proposes a panning shooting assist function that suppresses image blur in a main subject, which is the subject of the panning shooting, by using the image capturing apparatus shake detected through the stated method and a motion vector of the subject in a captured image.

[0006] Japanese Patent Laid-Open No. 2015-161730 focuses only on shake in the image capturing apparatus as obtained by a gyrosensor or the like. However, if the image capturing apparatus has an image stabilization function, accurately finding the amount of correction by an image stabilization mechanism (a correction position) is essential in order to find the movement amount of the subject more accurately, in addition to the motion vector calculated from the image and the amount of shake in the image capturing apparatus.

[0007] The relationship between the "motion vector calculated from the image", the "movement amount of the subject", the "amount of shake in the image capturing apparatus", and the "amount of correction by the image stabilization mechanism (the correction position)" will be described here with reference to FIGS. **25**A to **25**D. FIGS. **25**A to **25**D illustrate an example where an image capturing apparatus **1101** shoots two subjects, i.e., a subject **1103** and a subject **1104**. An optical image stabilization mechanism **1102** is assumed here to have a configuration that corrects image blur by moving the image sensor. Although this example assumes that the image stabilization is realized by the image sensor, a method which uses an optical image stabilization lens may be employed instead.

[0008] A shot image **1105** illustrated in FIG. **25**A is an image in which the subject **1103** and the subject **1104** have been shot, and the images of the subjects are a subject image **1106** and a subject image **1107**, respectively. A shot image **1110**, illustrated in FIG. **25**B, shows a state in which, of the subject **1103** and the subject **1104** in this composition, the subject **1103** has moved to the right, from a position P**1** to a position P**2**. At this time, the subject image **1106** in the shot image **1105** moves from the position p**1** to the position p**2** in the shot image **1110**. A motion vector **1113** is therefore found for the subject image **1106**, and a subject movement amount **1109** can be found for the subject **1103** on the basis thereof.

[0009] FIG. **25**C illustrates a state where the image capturing apparatus **1101** has shaken to the left from the state illustrated in FIG. **25**B (an image capturing apparatus shake amount **1121**). Assuming the angular velocity of the shake in the image capturing apparatus **1101** at this time is an angular velocity **1122**, a shot image **1120** is an image in which the angle of view is shifted to the left compared to the shot image **1110**. Thus in the shot image **1120**, the subject image **1106** and the subject image **1107** are shifted relatively to the right side, regardless of whether or not the subjects themselves have moved. As a result, the movement of the subject image **1106** in the shot image **1120** illustrated in FIG. **25**C is found as a motion vector **1125**. In other words, the motion vector **1125** is produced by the subject movement amount **1109**, which is the movement amount of the subject **1103** itself, and the image capturing apparatus shake amount **1121**, which is the amount of shake in the image capturing apparatus **1101**. The motion vector **1113** of the subject image **1106** can be found by subtracting a motion vector equivalent to the image capturing apparatus shake amount **1121** from the motion vector **1125**, and the subject movement amount **1109** of the subject **1103** can be found on the basis of the motion vector **1113**.

[0010] Furthermore, an image capturing apparatus having an image stabilization function typically carries out image stabilization continuously, which affects the images that are shot. FIG. **25**D illustrates a state where the optical image stabilization mechanism **1102** is carrying out image stabilization operations, with the image stabilization amount at that time represented by an image stabilization amount **1131**. As a result, a shot image **1130** illustrated in FIG. **25**D is an image shifted in the opposite direction relative to the shot image **1120** illustrated in FIG. **25**C, which cancels out the image capturing apparatus shake amount **1121**. As a result, the motion vector of the subject **1103** in the shot image **1130**, found from the position in the subject image **1106**, is a motion vector **1135**.

[0011] Here, the image stabilization function having completely canceled the image capturing apparatus shake amount **1121** with the image stabilization amount **1131** is equivalent to a state where the image capturing apparatus **1101** is completely stopped. This is the same as the shot image **1110** illustrated in FIG. **25**B and the shot image **1130** illustrated in FIG. **25**D. In other words, the motion vector **1135** is produced only by the subject movement amount **1109**. However, if the image capturing apparatus shake amount **1121** is high and thus cannot be completely corrected by the optical image stabilization mechanism **1102**, the image capturing apparatus shake amount **1121** will not be completely canceled out. Furthermore, the image capturing apparatus shake amount **1121** will not be completely canceled out when the photographer intentionally pans the apparatus to track a subject while the optical image stabilization mechanism **1102** functions with a delay. As such, the motion vector **1135** calculated from the shot image **1130** is produced by the image capturing apparatus shake amount **1121** and the image stabilization amount **1131**, in addition to the subject movement amount **1109**. In this case, the motion vector **1113** of the subject image **1106** can be found by subtracting a motion vector equivalent to the image capturing apparatus shake amount **1121** and the image stabilization amount **1131** from the motion vector **1135**, and the subject movement amount **1109** of the subject **1103** can be found on the basis of the motion vector **1113**.

[0012] Thus as described above, if the image capturing apparatus has an image stabilization function, accurately finding the amount of correction by the image stabilization mechanism (the correction position) is essential in order to find the movement amount of the subject more accurately, in addition to the motion vector calculated from the image and the amount of shake in the image capturing apparatus. An invention in which the amount of correction by an optical image stabilization mechanism is extracted in synchronization with the exposure timing of each horizontal line of an image sensor, the horizontal lines where a subject (called subject horizontal lines" hereinafter), and so on has therefore also been proposed.

[0013] Meanwhile, there are cases where, in an image capturing apparatus, the image sensor and an image signal processing unit which converts pixel data from the sensor are provided on a semiconductor device or circuit board different from a semiconductor device or circuit board on which a processing unit that calculates the motion vector, movement amount, and the like of a subject are provided. In this case, image data obtained from exposure, correction position information extracted in synchronization with the exposure timing, and the like must be exchanged with the processing units located on the different circuit boards. If the image data and the correction position information are exchanged using mutually-different communication circuits, lines for those communication circuit must be provided as well. This increases the space required for wiring, the number of connector pins, and the like on the circuit boards, which makes it difficult to keep the image capturing apparatus small. The image data and the correction position information must also be synchronized, which means that the data transfer must also be synchronized between the different communication units, which complicates the processing.

[0014] It is therefore desirable that the image data obtained from exposure and the correction position information extracted in synchronization with the exposure timing be exchanged between the processing units efficiently and while conserving space.

[0015] Furthermore, if the image capturing apparatus is an interchangeable lens-type apparatus and image stabilization is realized using an image stabilization function from an image stabilization lens or the like provided on the lens side, the image stabilization amount **1131** must be transmitted from the lens side to the main body side through some kind of method in order to find an accurate subject movement amount. Thus to find an accurate subject movement amount, it is essential to find the amount of correction by the image stabilization mechanism on the lens side (the correction position) accurately and transmit that from the lens side to the main body side, in addition to the motion vector calculated from the image and the amount of shake in the image capturing apparatus.

[0016] Furthermore, in an image capturing apparatus, there are cases where the image sensor, a processing unit that calculates the motion vector, the movement amount, and so on of a subject, and an image stabilization control unit are formed on the same circuit board or in the same semiconductor device, with a shake detection unit being formed on a different circuit board. For example, the shake detection unit must detect shake in the image capturing apparatus, and the shake detection unit and the image sensor must therefore be provided on different circuit boards in a configuration that carries out image stabilization by driving a movable image sensor. The detection result from the shake detection unit must therefore be transmitted among processing units provided on different circuit boards. If a dedicated communication circuit is used to exchange the detection results from the shake detection unit at this time, the dedicated communication circuit and wiring for that communication circuit must be provided as well. This increases the space required for wiring, the number of connector pins, and the like on the circuit boards, which increases the component costs and makes it difficult to keep the image capturing apparatus small.

SUMMARY OF THE INVENTION

[0017] The present invention has been made in consideration of the above situation, and finds an accurate position of an image stabilization mechanism corresponding to the exposure of a subject in order to increase the detection accuracy of a movement amount of the subject.

[0018] According to the present invention, provided is an image stabilizing apparatus comprising: a shake detector that detects shake; an image stabilizer that corrects the shake by moving a position on the basis of the shake detected by

the shake detector; a position detector that detects and outputs the position of the image stabilizer; a determinator that determines an extraction timing at which to extract the position of the image stabilizer on the basis of a timing at which an image sensor which shoots an image is exposed; and an extractor that extracts the position of the image stabilizer, from the output of the position detector, at the extraction timing determined by the determinator.

[0019] Further, according to the present invention, provided is an image processing apparatus comprising: a motion vector detector that detects a motion vector indicating movement of a subject on the basis of an image captured by an image sensor; and an acquisition circuit that acquires the motion vector detected by the motion vector detector and information from an image stabilizing apparatus; a moving amount detector that detects a movement amount of the subject on the basis of the information acquired by the acquisition circuit, wherein the image stabilization apparatus comprising: a shake detector that detects shake; an image stabilizer that corrects the shake by moving a position on the basis of the shake detected by the shake detector; a position detector that detects and outputs the position of the image stabilizer; a determinator that determines an extraction timing at which to extract the position of the image stabilizer on the basis of a timing at which an image sensor which shoots an image is exposed; and an extractor that extracts the position of the image stabilizer, from the output of the position detector, at the extraction timing determined by the determinator, and wherein the information includes a shake amount detected by the shake detector and the position of the image stabilizer extracted by the extractor.

[0020] Furthermore, according to the present invention, provided is a method of detecting a position of an image stabilizer, the method comprising: detecting shake; correcting the shake by moving the position of the image stabilizer on the basis of the detected shake; detecting and outputting the position of the image stabilizer; determining an extraction timing at which to extract the position of the image stabilizer on the basis of a timing at which an image sensor which shoots an image is exposed; and extracting, from the detected position of the image stabilizer, the position of the image stabilizer at the determined extraction timing.

[0021] Furthermore, according to the present invention, provided is a computer-readable storage medium storing a program that, in an image stabilizing apparatus including a shake detector that detects shake, an image stabilizer that corrects the shake by moving a position on the basis of the shake detected by the shake detector, and a position detector that detects and outputs the position of the image stabilizer, causes a computer to function as: a determinator that determines an extraction timing at which to extract the position of the image stabilizer on the basis of a timing at which an image sensor which shoots an image is exposed; and an extractor that extracts the position of the image stabilizer, from the output of the position detector, at the extraction timing determined by the determinator.

[0022] Further features of the present invention will become apparent from the following description of exemplary embodiments (with reference to the attached drawings).

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention, and together with the description, serve to explain the principles of the invention.

[0024] FIG. **1** is a block diagram illustrating an example of the overall configuration of an image capturing apparatus according to embodiments of the present invention.

[0025] FIG. **2** is a flowchart illustrating the flow of shooting by the image capturing apparatus according to embodiments.

[0026] FIG. **3** is a block diagram illustrating, in detail, a configuration involved in a subject movement detection process according to a first embodiment.

[0027] FIGS. **4**A and **4**B are diagrams illustrating the timing at which position information of an image stabilization mechanism is extracted, according to the first embodiment.

[0028] FIG. **5** is a block diagram illustrating, in detail, a configuration involved in a subject movement detection process according to a second embodiment.

[0029] FIG. **6** is a diagram illustrating the timing at which position information of an image stabilization mechanism is extracted, according to the second embodiment.

[0030] FIG. **7** is a diagram illustrating the timing at which position information of the image stabilization mechanism is extracted, in a case where there are a plurality of subjects, according to the second embodiment.

[0031] FIG. **8** is a block diagram illustrating, in detail, a configuration involved in a subject movement detection process according to a third embodiment.

[0032] FIG. **9** is a diagram illustrating the timing at which position information of an image stabilization mechanism is extracted, according to the third embodiment.

[0033] FIG. **10** is a block diagram illustrating another configuration involved in the subject movement detection process, according to the third embodiment.

[0034] FIG. **11** is a block diagram illustrating, in detail, a configuration involved in a subject movement detection process according to a fourth embodiment.

[0035] FIG. **12** is a diagram illustrating an example of the configuration of a transmission packet according to the fourth embodiment.

[0036] FIGS. **13**A to **13**C are diagrams illustrating the configuration of the transmission packet according to the fourth embodiment.

[0037] FIG. **14**A is a diagram illustrating an example of the configuration of a transmission packet according to a fifth embodiment.

[0038] FIG. **14**B is a diagram illustrating an example of the configuration of a transmission packet according to the fifth embodiment.

[0039] FIG. **14**C is a diagram illustrating an example of the configuration of a transmission packet according to the fifth embodiment.

[0040] FIG. **15** is a block diagram illustrating, in detail, a configuration involved in a subject movement detection process according to a sixth embodiment.

[0041] FIG. **16** is a diagram illustrating the timing at which position information of an image stabilization mechanism is extracted, according to the sixth embodiment.

[0042] FIG. **17** is a block diagram illustrating, in detail, a configuration involved in a subject movement detection process according to a seventh embodiment.

[0043] FIG. **18** is a diagram illustrating the timing at which position information of an image stabilization mechanism is extracted, according to the seventh embodiment.

[0044] FIG. **19** is a diagram illustrating the timing at which position information of an image stabilization mechanism is extracted, in a case where there are a plurality of subjects, according to the seventh embodiment.

[0045] FIG. **20** is a block diagram illustrating, in detail, a configuration involved in a subject movement detection process according to an eighth embodiment.

[0046] FIG. **21** is a diagram illustrating the timing at which position information of image stabilization mechanisms is extracted, according to the eighth embodiment.

[0047] FIG. **22** is a block diagram illustrating, in detail, a configuration involved in a subject movement detection process according to ninth and tenth embodiments.

[0048] FIG. **23** is a diagram illustrating the timing at which camera shake amounts from a camera shake detection unit are extracted, according to the ninth embodiment.

[0049] FIG. **24** is a diagram illustrating the timing at which camera shake amounts from a camera shake detection unit are extracted, according to the tenth embodiment.

[0050] FIGS. **25**A to **25**D are diagrams illustrating a relationship between a motion vector, an image capturing apparatus, and a subject.

DESCRIPTION OF THE EMBODIMENTS

[0051] Exemplary embodiments of the present invention will be described in detail in accordance with the accompanying drawings. The embodiments describe an image stabilizing apparatus, which stabilizes a shot image, as an example. An image stabilizing apparatus which controls the driving of a movable member or the like in an image stabilization optical system can be provided in image capturing apparatuses such as video cameras or digital cameras, optical devices including observation apparatuses such as binoculars, telescopes, and field scopes, and the like.

[0052] FIG. **1** is a block diagram illustrating an example of the overall configuration of an image capturing system according to embodiments of the present invention, and illustrates the configuration of a camera body **120** (the main body of an image capturing apparatus), which is a mirrorless camera having an image stabilization function, and an interchangeable lens **100**.

[0053] The interchangeable lens is an optical device that can be attached to and removed from the camera body **120**, and may be any of a variety of types of lenses. The interchangeable lens **100** described here includes an imaging lens unit **101** constituted by a main optical imaging system **102**, a zoom lens group **103** capable of changing the focal length, and an image stabilization lens group **104** that corrects image blur. A zoom encoder **105** detects the position of the zoom lens group **103** and outputs a detection signal to a lens focal length detection unit **109** within a lens control unit **108**. The lens focal length detection unit **109** can obtain the focal length of the imaging lens unit **101** from the detection signal provided by the zoom encoder **105**.

[0054] An image stabilization lens position sensor **106** detects the position of the image stabilization lens group **104**, which is driven by an image stabilization lens actuator **107**, and outputs a detection signal to a lens image stabilization control unit **112**. An interchangeable lens shake detection unit **113** detects shake in the interchangeable lens **100**, and outputs a shake detection signal (a shake amount) to the lens image stabilization control unit **112**. The lens image stabilization control unit **112** carries out image stabilization operations by driving the image stabilization lens group **104** in directions perpendicular to the optical axis thereof on the basis of the shake detection signal. In other words, the lens image stabilization control unit **112** finds an amount of correction for the image stabilization lens group **104** on the basis of the position of the image stabilization lens group **104** and the shake amount in the interchangeable lens **100**, and uses that amount of correction to control the image stabilization.

[0055] A mount contact unit **114** is a unit for connection with the camera body **120**, and communicates with the camera body **120** under the control of a lens communication control unit **111**. The lens control unit **108** also controls the focus, aperture, and the like (not illustrated here).

[0056] The camera body **120** includes a camera system control microcomputer **160** (called a "camera control unit" hereinafter), a shutter **121** used in exposure control, an image sensor **150** such as a CMOS sensor, and the like. The shutter **121** is driven by a shutter actuator **122**, and the driving is controlled by a shutter control unit **124** via a shutter driver **123**. A plurality of pixels are arranged in a matrix in the image sensor **150**. Operation timings are set by an exposure timing control unit **152**, and an image is generated by processing output signals from the image sensor **150** using an image signal processing unit **151**.

[0057] A camera shake detection unit **134** detects shake in the camera body **120** and outputs a shake detection signal to a camera stabilization control unit **135**. The image sensor **150** is driven in directions perpendicular to the optical axis by a camera stabilization actuator **132**, and the position of the sensor is output to the camera stabilization control unit **135** by a camera stabilization position sensor **131**. The camera stabilization control unit **135** performs image stabilization control of the camera body **120** by finding an amount of correction on the basis of the output from the camera shake detection unit **134** and the position information of the image sensor **150**, and driving the camera stabilization actuator **132** on the basis of that amount of correction using a camera stabilization driver **133**.

[0058] A display unit **171** includes a display device, such as a liquid crystal panel (LCD), that makes displays for a user to monitor the image he or she intends to shoot with the camera, displays for the user to confirm images that have been shot, and the like. A storage medium **172** is a recording medium, such as a memory card, that records the data of shot images. An operating unit **173** includes a power switch, a release switch, a switch for setting various modes, and the like.

[0059] A mount contact unit **141** is a connection unit provided for connecting the camera body **120** and the interchangeable lens **100**. The lens communication control unit **111** and a camera communication control unit **142** communicate at predetermined timings through the mount contact unit **114** and the mount contact unit **141**.

[0060] A subject position detection unit **161** detects various types of subjects, such as a main subject and a background, from an image output from the image signal processing unit **151**. A motion vector detection unit **162** calculates a motion vector of a subject from differences in the image data between a plurality of frames. A subject movement amount detection unit **163** detects movement (a movement amount) of a subject on the basis of the shake detection signal from the camera shake detection unit **134**,

the motion vector from the motion vector detection unit **162**, and the position information from the camera stabilization position sensor **131**.

[0061] The camera body **120** also includes various other control blocks, such as a white balance control unit, but these have not been illustrated for the sake of simplicity. Furthermore, during image stabilization, detection and correction processes are executed for two orthogonal axes, e.g., in horizontal and vertical directions. However, these processes use the same configurations, and thus the following descriptions will focus on only a single axis.

[0062] FIG. **2** is a flowchart illustrating the flow of shooting by the image capturing apparatus configured as described above, according to the present invention. The flow of shooting by the image capturing apparatus will be described next with reference to FIG. **2**.

[0063] Once the image capturing apparatus is turned on, first, an initialization process for making shooting preparations is carried out (step S**201**). Having finished the initialization process, the image capturing apparatus starts driving the image sensor **150**, and starts obtaining a subject image (step S**202**). At this time, if the image stabilization function is set to active (YES in step S**203**), an image stabilization process is carried out by the various image stabilization mechanisms (step S**204**), after which the process moves to step S**205**. If the image stabilization function is not active, the process moves to step S**205** without carrying out the image stabilization process.

[0064] Next, in step S**205**, the image capturing apparatus determines whether or not recording has been started. If recording has not been started, the process moves to step S**206**, where it is determined whether or not a trigger to start shooting has been produced by the release button in the operating unit **173** being operated. If the trigger to start shooting has been produced, the process moves to step S**207**. Recording is started, and the process moves to step S**212**. However, if the trigger to start shooting has not been produced, the process moves directly to step S**212**.

[0065] If the recording has already been started, the process moves to step S**208**, where it is determined whether or not a trigger to end shooting has been produced by the release button of the operating unit **173** being operated. If the trigger to end shooting has not been produced, the process moves to step S**209**, where a recording process is carried out. Then, the shot image is saved into the recording medium in step S**210**, after which the process moves to step S**212**. On the other hand, if the trigger to end shooting has been produced, the process moves to step S**211**, where the recording is stopped. The process then moves to step S**212**.

[0066] In this manner, when a trigger is produced by the release button being operated while recording has not yet been started, the recording is started. The recording process is continued until the trigger is produced again, whereupon the shot image is saved into the recording medium. When the trigger is produced again after the recording was started, the recording is stopped.

[0067] In step S**212**, the position of a subject in the image obtained by the image sensor **150** is detected. In step S**213**, movement of the subject is detected on the basis of the position of the subject detected previously and the position of the subject detected at present. Note that the present invention assumes that the subject position detection process (step S**212**) and the subject movement detection process (S**213**) are carried out continuously while the image sensor **150** is operating, regardless of whether or not recording is taking place. Such being the case, the position and movement of the subject can be detected and predicted even while in a waiting state, which makes it possible to realize various shooting functions.

[0068] In step S**214**, it is determined whether or not an operation for turning the power off, such as the power button in the operating unit **173** being operated, has been made. If the power has not been turned off, the process returns to step S**203**, and the above-described processing is repeated. However, if the power has been turned off, the end process is performed in step S**215**. The image capturing apparatus is turned off, and the flow of the shooting ends.

First Embodiment

[0069] FIG. **3** is a block diagram illustrating, in further detail, a configuration used for a subject movement detection process according to a first embodiment of the present invention. Note that elements that are the same as those shown in FIG. **1** are given the same reference numerals. Furthermore, the elements in FIG. **1** not directly related to the subject movement detection process according to the first embodiment are not shown.

[0070] The camera stabilization control unit **135** includes a position feedback control unit **211** and a control target value generating unit **212**. The control target value generating unit **212** generates a control target value, for carrying out position feedback control with the position feedback control unit **211**, on the basis of the output from the camera shake detection unit **134**. The position feedback control unit **211** finds a target position for the image sensor **150**, and calculates an operation amount, on the basis of the control target value and the position information from the camera stabilization position sensor **131**, and then carries out the position feedback control, which controls the driving of the camera stabilization actuator **132**. An image stabilization function that suppresses image blur, a smooth panning operation, and the like can be realized using the control target value generated by the control target value generating unit **212**.

[0071] A stabilization position extracting unit **204** extracts a value from the output of the camera stabilization position sensor **131** at a specific timing. That timing is set by a timing notifying unit **201** included in the exposure timing control unit **152**. An output from the timing notifying unit **201** depends on shooting conditions or the like set in the exposure timing control unit **152**. This will be described in greater detail later. The subject movement amount detection unit **163** detects the movement amount of the subject on the basis of the outputs from the subject position detection unit **161**, the motion vector detection unit **162**, the stabilization position extracting unit **204**, and the camera shake detection unit **134**.

[0072] The timing of the extraction by the stabilization position extracting unit **204** in a case where the present embodiment is employed will be described next with reference to FIGS. **4**A and **4**B. In FIG. **4**A, a signal **401** is a synchronization signal, and the period thereof corresponds to the framerate. Exposure periods **402***a*, **402***b*, and **402***c*, which correspond to first, second, and third frames, respectively, correspond to exposure periods for the frames. The present embodiment assumes that a CMOS sensor is used as the image sensor **150**, and exposure periods are indicated for each period corresponding to the framerate. If the CMOS

sensor is driven through a rolling shutter, the readout timing is different for each horizontal readout line of the image sensor **150**. In FIG. **4**A, the readout is carried out in order from a horizontal readout line **411** at the top, to a horizontal readout line **412**, a horizontal readout line **413**, and so on up to a horizontal readout line **419**. Thus as can be seen from the exposure period **402***a* too, the exposure timing shifts from the horizontal readout line **411** at the top to the horizontal line **419** at the bottom.

[0073] A signal **403** is the output from the timing notifying unit **201**, and indicates the timing at which the stabilization position extracting unit **204** extracts the position information from the camera stabilization position sensor **131**.

[0074] In the present embodiment illustrated in FIG. **4**A, the extraction timing is set to a central time, which corresponds to the center of the exposure period in each horizontal readout line of the image sensor **150**. For example, the central time of the exposure period for the horizontal readout line **411** at the top is a time t**1**. At that time t**1**, the timing notifying unit **201** notifies the stabilization position extracting unit **204** that it is the timing for extracting the position information, and the stabilization position extracting unit **204** extracts the position information. Likewise, the stabilization position extracting unit **204** extracts the position information in order, at a time t**2** for the horizontal readout line **412**, at a time t**3** for the horizontal readout line **419**, and so on. The same applies to the exposure periods **402***b* and **402***c*, which are the second and third exposure periods, respectively.

[0075] As a result, the output of the camera stabilization position sensor **131**, corresponding to each horizontal readout line, is extracted. An accurate amount of correction for the image stabilization mechanism can be found for each horizontal readout line on the basis of the extracted position information from the camera stabilization position sensor **131** and the focal length of the optical system at that point in time. Furthermore, because the amount of correction is found for each horizontal readout line, the amount of correction can also be calculated according to the subject, if the region of the subject is found as well.

[0076] For example, assuming a subject **406** is present as illustrated in FIG. **4**B, a plurality of horizontal readout lines corresponding to the position of the subject **406** correspond to subject lines **407**. The amount of correction for the image stabilization mechanism in each frame corresponding to those subject lines **407** matches that obtained at extraction timings **440***a* to **440***c*.

[0077] Note that the position information of the subject found by the subject position detection unit **161** may be transmitted to the stabilization position extracting unit **204**, and the position information from the camera stabilization position sensor **131**, corresponding to the subject lines **407**, may be extracted by the stabilization position extracting unit **204**, and then transmitted to the subject movement amount detection unit **163**.

[0078] Although the present embodiment describes a method of determining the extraction timing for each horizontal readout line in the image sensor **150**, the extraction may occur for the horizontal readout line every set interval instead.

[0079] According to the first embodiment as described thus far, an accurate amount of correction for the image stabilization mechanism can be obtained, which makes it possible to find a more accurate subject movement amount.

Second Embodiment

[0080] A second embodiment of the present invention will be described next with reference to FIGS. **5** to **7**.

[0081] FIG. **5** is a block diagram illustrating, in further detail, a configuration used for a subject movement detection process according to the second embodiment of the present invention. Note that elements that are the same as those illustrated in FIG. **3** are given the same reference numerals, and will not be described. The configuration illustrated in FIG. **5** differs from the configuration illustrated in FIG. **3** in that the various types of subject information detected by the subject position detection unit **161** are output to the timing notifying unit **201**.

[0082] The timing of the extraction carried out by the stabilization position extracting unit **204** according to the second embodiment will be described next with reference to FIG. **6**. As in FIGS. **4**A and **4**B, the signal **401** is a synchronization signal synchronized with the frames. A signal **603** is a signal, output from the timing notifying unit **201**, which indicates the timing at which the position information from the camera stabilization position sensor **131** is extracted. Exposure periods **602***a* to **602***c* correspond to the exposure periods of individual frames.

[0083] As illustrated in FIG. **6**, the second embodiment assumes that a subject **606** is present in a shot image **605**, and that the position of the subject **606** at that time is detected by the subject position detection unit **161**. If the position of the subject **606** has been found, subject lines **607**, which are the range of horizontal readout lines in the image sensor **150** corresponding to the position of the subject **606**, can be found as well. Furthermore, the exposure periods corresponding to the subject lines **607** can be found on the basis of the shooting conditions and the like, as subject exposure periods **608**. A time t**21** that is the center of the exposure time of a line at the center of the subject lines **607** is the central time of the subject exposure period **608**. Accordingly, extracting the position information from the camera stabilization position sensor **131** at time t**21** makes it possible to calculate a stabilization correction amount corresponding to the subject **606**. In the same manner, the position information from the camera stabilization position sensor **131** is extracted at times t**22** and t**23** for the exposure periods **602***b* and **602***c*, which are the second and third exposure periods, respectively.

[0084] FIG. **7** illustrates the timing of extraction when there are two subjects, namely subjects **706** and **707**, in a shot image **705**. In this case as well, using the same concept as that described with reference to FIG. **6**, the position information from the camera stabilization position sensor **131** is extracted at a central time t**25** of subject exposure periods **710** of subject lines **708**, which are the range of horizontal readout lines in the image sensor **150** corresponding to the subject **706**. Similarly, the position information from the camera stabilization position sensor **131** is extracted at a central time t**24** of subject exposure periods **711** of subject lines **709**, which are the range of horizontal readout lines corresponding to the subject **707**. The same applies to the exposure periods **602***b* and **602***c*, which are the second and third exposure periods, respectively.

[0085] As described earlier, the information extraction timing is determined in accordance with the position of the subject in the shot image, in addition to the shooting conditions. Accordingly, as illustrated in FIG. **5**, the position

information of the subject, as found by the subject position detection unit **161**, is required by the timing notifying unit **201** to determine the timing.

[0086] According to the second embodiment as described thus far, an accurate amount of correction for the image stabilization mechanism can be obtained, which makes it possible to find a more accurate subject movement amount.

Third Embodiment

[0087] A third embodiment of the present invention will be described next with reference to FIGS. **8** to **10**.

[0088] FIG. **8** is a block diagram illustrating, in further detail, a configuration used for a subject movement detection process according to the third embodiment of the present invention. Note that elements that are the same as those illustrated in FIGS. **3** and **5** are given the same reference numerals, and will not be described. The configuration illustrated in FIG. **8** differs from the configuration illustrated in FIG. **5** in that in FIG. **8**, the camera stabilization control unit **135** includes the stabilization position extracting unit **204**, and that the stabilization position extracting unit **204** further includes a stabilization position computation processing unit **205**.

[0089] The timing of the extraction carried out by the stabilization position extracting unit **204** according to the third embodiment will be described next with reference to FIG. **9**. FIG. **9** illustrates signal timings according to the third embodiment. As in FIG. **6**, the signal **401** is a synchronization signal synchronized with the frames. A signal **903** is a signal, output from the timing notifying unit **201**, which indicates the timing at which the position information from the camera stabilization position sensor **131** is extracted. Exposure periods **602***a* to **602***c* correspond to the exposure periods of individual frames.

[0090] As illustrated in FIG. **9**, the third embodiment also assumes that the subject **606** is present in the shot image **605**, and that the position of the subject **606** at that time is detected by the subject position detection unit **161**. The subject exposure periods **608** are the exposure periods corresponding to the subject lines **607** which are the horizontal readout lines where the subject **606** is located. The time t**21** that is the center of the exposure time of a line at the center of the subject lines **607** is the central time of the subject exposure period **608**.

[0091] In FIG. **9**, a signal **921** indicates the position information output from the camera stabilization position sensor **131** in time series according to the third embodiment, and a signal **924** is obtained by filtering that time series data.

[0092] In the third embodiment, the position information from the camera stabilization position sensor **131** is obtained at a set cycle during the subject exposure period **608**, and that time series data is subjected to a filtering computation process for removing noise, such as low-pass filter (LPF) processing. The information at time t**21** is extracted from the position information that has undergone the LPF processing. By doing so, even if there is noise in the position information at the time of extraction, that noise can be removed.

[0093] For example, if the camera body **120** has been subjected to a temporary impact at time t**21**, that impact will propagate to the image sensor **150** as well, and will be observed as noise in the output of the camera stabilization position sensor **131** as a result. The noise resulting from that impact is represented by a pulse **922**. If the timing of that pulse **922** coincides with the extraction time t**21**, position data **923** will be extracted as the position information from the camera stabilization position sensor **131**, corresponding to the subject **606**.

[0094] However, the position feedback control unit **211** is carrying out feedback control, and thus even if the position is shifted for an instant by the impact, the image sensor **150** immediately returns to the desired position. As such, the positional shift of the image sensor **150** caused by the impact occurs only for an instant with respect to the subject exposure period **608**, and therefore produces almost no effect on the exposed image **905**. The required information in the present invention is the stabilization correction amount for an exposed shot image, and thus the information to be extracted at the extraction timing t**21** is not the position data **923** of the position information at the time of the impact, but rather the position information of the exposure periods before and after the impact. Carrying out the LPF processing described earlier, as in the present embodiment, makes it possible to obtain the desired position information.

[0095] Accordingly, in the present embodiment, the stabilization position computation processing unit **205** is provided in the stabilization position extracting unit **204**, as illustrated in FIG. **8**. The position information is then extracted after using the stabilization position computation processing unit **205** to carry out filtering processing, such as LPF processing, to remove noise. Although an LPF is used for noise removal in the third embodiment, a smoothing process may instead be carried out through another type of computation, such as an averaging process.

[0096] According to the third embodiment as described thus far, an accurate amount of correction for the image stabilization mechanism can be obtained even when the camera body **120** has been subjected to a temporary impact, which makes it possible to find a more accurate subject movement amount.

[0097] The foregoing describes an example of a configuration in which the image sensor **150**, the camera stabilization control unit **135**, the exposure timing control unit **152**, and the stabilization position extracting unit **204** are separate units. However, a processing block **210** constituted by a logic circuit that integrates the camera stabilization control unit **135**, the exposure timing control unit **152**, and the stabilization position extracting unit **204** may be configured, and that processing block **210** may be integrated with the image sensor **150**, as illustrated in FIG. **10**. Doing so makes it easy to link the signals among the blocks to each other, which in turn makes it possible to realize faster and more accurate signal processing.

Fourth Embodiment

[0098] A fourth embodiment of the present invention will be described next with reference to FIGS. **11** to **13**C.

[0099] FIG. **11** is a block diagram illustrating, in detail, a configuration used for a subject movement detection process according to the fourth embodiment of the present invention. The configuration illustrated in FIG. **11** corresponds to the configuration illustrated in FIG. **3**, but divided between two circuit boards. Accordingly, a configuration and a control unit for communication between the two circuit boards has been added. Note that elements that are the same as those illustrated in FIG. **3**, **5**, or **8** are given the same reference numerals, and will not be described.

[0100] In FIG. **11**, an image stabilization circuit **301** is a circuit block including the image sensor **150**, the camera

stabilization control unit **135**, and the like, and is formed on a single semiconductor device, circuit board, or the like. A camera control circuit **302** is a circuit block including a camera control unit **160**, the motion vector detection unit **162**, the subject movement amount detection unit **163**, and the like, and is formed on a different circuit board or semiconductor device from the image stabilization circuit **301**.

[0101] An image capturing control unit **311** is configured in the image stabilization circuit **301**, and receives control information pertaining to image capturing from the camera control unit **160**, via an image capturing control signal receiving unit **312** configured in the image stabilization circuit **301** and an image capturing control signal transmitting unit **313** configured in the camera control circuit **302**. Shooting conditions such as the exposure period, a pixel readout algorithm for the image sensor **150**, and so on are set using the received control information, to control the image sensor **150**, the exposure timing control unit **152**, and the like, as well as to control the image signal processing unit **151** and the like.

[0102] The stabilization position extracting unit **204** extracts the output of the camera stabilization position sensor **131** at the timings described above with reference to FIGS. **4**A and **4**B, FIG. **6**, or FIG. **7**, in response to a signal from the timing notifying unit **201**.

[0103] A communication packet transmitting unit **322** configured in the image stabilization circuit **301** and a communication packet receiving unit **323** configured in the camera control circuit **302** are communication blocks that pass data from the image stabilization circuit **301** to the camera control circuit **302**. At this time, packet data generated by a transmission packet generating unit **321**, transmitted from the communication packet transmitting unit **322**, is analyzed by a received packet processing unit **324**, and is then passed to the respective processing blocks of the camera control circuit **302** as data. The transmission packet generating unit **321** includes a header generating unit **325** that generates a header to be added to the packet data, and a payload generating unit **326** that generates the payload of the packet data. This header and payload include pixel data for each horizontal line, position information of the image stabilization mechanism, the shooting conditions, the subject position, and so on, as well as other information for identification, which will be described in detail later.

[0104] The subject movement amount detection unit **163** detects the movement amount of the subject on the basis of the outputs of the motion vector detection unit **162** and the camera shake detection unit **134**, and the pixel data, position information of the image stabilization mechanism, subject position, and the like extracted from the packet data that has been analyzed by the received packet processing unit **324**.

[0105] FIG. **12** is a diagram illustrating an example of the format of the packets generated by the transmission packet generating unit **321** and used to transmit a single frame's worth of image data. A pixel data region **1201** illustrated in FIG. **12** indicates the region of the pixel data to be transmitted, and an active pixel region **1211** is a region of active pixels in a single frame of an image captured by the image sensor **150**. A margin region **1212**, which has the same number of pixels in the vertical direction as the number of pixels in the vertical direction in the active pixel region **1211**, is set on the left side of the active pixel region **1211**. A forward dummy region **1213**, which has the same number of pixels in the horizontal direction as the overall number of pixels in the active pixel region **1211** and the margin region **1212** in the horizontal direction, is set above the active pixel region **1211**. In FIG. **12**, embedded data **1215** is inserted into the forward dummy region **1213**. The embedded data **1215** includes information such as setting values pertaining to the image capturing by the image sensor **150**, including the shutter speed, gain, and the like, as well as the subject position and so on. A rear dummy region **1214**, which has the same number of pixels in the horizontal direction as the overall number of pixels in the active pixel region **1211** and the margin region **1212** in the horizontal direction, is set below the active pixel region **1211**. Note that the embedded data **1215** may also be inserted into the rear dummy region **1214**. The pixel data region **1201** is constituted by the active pixel region **1211**, the margin region **1212**, the forward dummy region **1213**, and the rear dummy region **1214**.

[0106] The band on the upper side in FIG. **12** indicates the structure of the packet data used in the transmission according to the present embodiment. When a string of pixels in the horizontal direction is taken as a line, the pixel data of each line constituting the pixel data region **1201** is held in the payload of the packet. A single packet is constituted by adding a header and footer, as well as control codes such as a start code before the header and an end code after the footer, to a payload holding one line's worth of pixel data. Note that the footer is added as an option, and a control code such as an end code is added after the payload if a footer is not added.

[0107] As will be described later, the header includes additional information for the pixel data held in the payload, such as Frame Start, Frame End, Line Valid, Line Number, ECC, and the like. By employing a format that transmits the pixel data constituting a single frame of an image on a line-by-line basis in this manner, additional information such as the header, control codes such as the start code and the end code, and so on can be transferred during the blanking period for each line.

[0108] The entirety of one frame's worth of image data is transferred using a number of packets greater than or equal to the number of pixels in the pixel data region **1201** in the vertical direction.

[0109] The bands on the left side and the bottom of FIG. **12** indicate the content of the header information. FIG. **13**A is a diagram collectively illustrating the format of the packets indicated at the top of FIG. **12**, details of the header information indicated at the bottom of FIG. **12**, and Reserve content. FIG. **13**B illustrates an example of the content of the header information and the amount of that information.

[0110] Frame Start is 1-bit information indicating the start of the frame. A value of 1 is set for the Frame Start of the header of the packet used to transfer the first line of pixel data in the pixel data region **1201** illustrated in FIG. **12**, whereas a value of 0 is set for the Frame Start of the headers of the packets used to transfer the pixel data of the other lines. Frame End is 1-bit information indicating the end of the frame. A value of 1 is set for the Frame End of the header of the packet including the pixel data of the final line in the active pixel region **1211** in its payload, whereas a value of 0 is set for the Frame End of the headers of the packets used to transfer the pixel data of the other lines. The Frame Start and Frame End serve as "frame information", which is information pertaining to the frame.

[0111] Line Active is 1-bit information indicating whether or not a line in the pixel data held in the payload is a line of active pixels. A value of 1 is set for the Line Active of the header of the packet used to transfer the pixel data of the line within the active pixel region **1211**, whereas a value of 0 is set for the Line Active of the headers of the packets used to transfer the pixel data of the other lines. Line Number is 13-bit information expressing a line number of a line constituted by the pixel data held in the payload. Embedded Line is 1-bit information indicating whether or not the packet is a packet used to transfer a line in which embedded data is inserted. For example, a value of 1 is set for the Embedded Line of the header of a packet used to transfer a line including embedded data, whereas a value of 0 is set for the Embedded Line of the headers of packets used to transfer other lines. As described earlier, the embedded data is inserted into a predetermined line in the forward dummy region **1213** and the rear dummy region **1214**. The Line Active, Line Number, and Embedded Line serve as "line information", which is information pertaining to the lines.

[0112] A Data ID is information for identifying the data held in the payload, whereas Reserve is a region used for extension. A method for using the Data ID and the Reserve in the present embodiment will be described later. Note that 0 being set for the Data ID in FIG. **12** is assumed to indicate that the data held in the payload is pixel data. Header ECC is information including an error detection code calculated on the basis of the header information.

[0113] In the fourth embodiment, the position information of the image stabilization mechanism is added to the Reserve region. As illustrated in FIG. **13**A, the position information of the image stabilization mechanism is held in a position information region **1301** in a Reserve extension region, as 24-bit information. Accordingly, of the 29 bits available in the Reserve region, 24 bits are used for the position information region **1301**, and the remaining 5 bits are used as the Reserve region. FIG. **13**C illustrates the overall transmission packet of a single frame at that time. It can be seen that in the packet of an active pixel line in the Nth line, position information **1302** when the Nth line was exposed is added to the Reserve region, pixel data **1303** is added to the payload data, and the packet is sent in that state.

[0114] Configuring the transmission packet in this manner makes it possible to send the pixel data and position information in the same horizontal line in the same transmission packet, which makes it easy to handle the pixel data and position information in synchronization with each other.

[0115] Although the foregoing describes an example in which the configuration illustrated in FIG. **3** is divided between two circuit boards, the configurations illustrated in FIGS. **5** and **8** can also be divided between two circuit boards as well. In such a case, the control described with reference to FIGS. **6** and **7**, and FIG. **9**, respectively, can be carried out.

Fifth Embodiment

[0116] A fifth embodiment of the present invention will be described next with reference to FIGS. **14**A to **14**C. With reference to FIGS. **14**A to **14**C, position information transmission methods that uses different formats will be explained. Note that the fifth embodiment is assumed to employ the configuration illustrated in FIG. **11**, which will therefore not be described here.

[0117] According to the format illustrated in FIG. **14**A, the position information is divided into "reference information" and "differential information" and transmitted. The position information, which serves as a reference for the frame (reference position information), is added as embedded data, and in the packet for each horizontal line, a differential value from the reference position information (differential position information) is added to the Reserve region. In FIG. **14**A, the embedded data is inserted into the forward dummy region **1213**, and reference position information **1401**, which serves as a reference for that frame, is held in part of that data. Differential position information **1402** is held in the Reserve region as the difference between the position information at that time and the reference position information **1401**, in the packet for the Nth line of the active pixel region **1211**. Doing so makes it possible to reduce the data size of the differential position information **1402** held in the Reserve region of each packet.

[0118] The format illustrated in FIG. **14**B assumes that the position information is added to the payload data that up until this point has held the pixel data and the embedded data. To realize this, a Data ID **1403**, included in the header information as described earlier, is used. The Data ID **1403** is header information for identifying the data held in the payload. In FIG. **14**B, a Data ID of 0 is set in a case where the data held in the payload is pixel data, and a Data ID of 1 is set in a case where position information **1404** is held in the payload. Doing so makes it possible to transmit the pixel data and position information of each horizontal line in transmission packets while identifying the data and information, which in turn makes it possible to send position information with a larger amount of data.

[0119] Furthermore, with the format illustrated in FIG. **14**C, the position information for each horizontal line is not transmitted, and instead, position information that has already undergone computational processing, corresponding to the known subject horizontal lines, is added. In this case, the image stabilization circuit **301** and the camera control circuit **302** illustrated in FIG. **11** have configurations obtained by dividing the configuration illustrated in FIG. **5** or FIG. **8**. Although the "computational processing" mentioned here is the averaging, filtering, or the like described in the third embodiment, the position information obtained through the method described in the second embodiment may be used as the position information. At this time, the information may be added at the frame level, rather than at the horizontal line level. Thus in FIG. **14**C, a Data ID **1405** is set to 1, and frame position information **1406** is added to the embedded data.

[0120] Thus according to the fifth embodiment, the position information of the image stabilization mechanism based on the exposure period of the subject is extracted, and that information is added to the transmitted image data. This makes it possible to calculate an accurate movement amount for the subject without using complicated transmission paths or transmission processes.

Sixth Embodiment

[0121] A sixth embodiment of the present invention will be described next with reference to FIGS. **15** to **16**.

[0122] FIG. **15** is a block diagram illustrating, in further detail, a configuration used for a subject movement detection process according to the sixth embodiment of the present invention. Note that elements that are the same as

those illustrated in FIG. **1** are given the same reference numerals, and will not be described. Furthermore, the elements in FIG. **1** not directly related to the subject movement detection process according to the sixth embodiment are not shown.

[0123] The lens image stabilization control unit **112** includes a position feedback control unit **213** and a control target value generating unit **214**. The control target value generating unit **214** generates a control target value, for carrying out position feedback control with the position feedback control unit **213**, on the basis of the output from the interchangeable lens shake detection unit **113**. On the basis of the control target value and the position information from the image stabilization lens position sensor **106**, the position feedback control unit **213** finds a target position for the image stabilization lens group **104** and calculates an operation amount, and carries out position feedback control, which controls the driving of the image stabilization lens actuator **107**. An image stabilization function that suppresses image blur, a smooth panning operation, and the like can be realized using the control target value generated by the control target value generating unit **214**.

[0124] A lens stabilization position extracting unit **215** extracts position information from the output of the image stabilization lens position sensor **106** at a specific timing, the timing being determined by the timing notifying unit **201** of the exposure timing control unit **152**, provided on the camera body **120** side.

[0125] The lens stabilization position extracting unit **215** transfers the output of the image stabilization lens position sensor **106**, extracted on the basis of the output from the timing notifying unit **201**, to a stabilization position extracting unit **204** on the camera body **120** side. As described earlier, the communication between the interchangeable lens **100** and the camera body **120** is carried out by the lens communication control unit **111** and the camera communication control unit **142**.

[0126] FIG. **16** is a diagram illustrating the timing of the extraction by the lens stabilization position extracting unit **215** according to the sixth embodiment. Note that the same signals and the like as those illustrated in FIGS. **4**A and **4**B are given the same reference numerals.

[0127] In the present embodiment, the timing at which the lens stabilization position extracting unit **215** extracts the position information from the image stabilization lens position sensor **106** is the same as the timing at which the stabilization position extracting unit **204** extracts the position information from the camera stabilization position sensor **131**, described with reference to FIGS. **4**A and **4**B. For example, the position information is extracted at time t**61**, corresponding to the uppermost horizontal readout line **411**. The lens stabilization position extracting unit **215** extracts the position information sequentially in a similar manner, at time t**62** corresponding to the horizontal readout line **412**, and at time t**63** corresponding to the final horizontal readout line **419**. The same applies to the exposure periods **402***b* and **402***c*, which are the second and third exposure periods, respectively.

[0128] The timing notifying unit **201** notifies the lens stabilization position extracting unit **215** of the extraction timing using the signal **403**, and the lens stabilization position extracting unit **215** extracts the position information from the output of the image stabilization lens position sensor **106**. The lens stabilization position extracting unit **215** then transfers the obtained position information to the lens communication control unit **111**, and the lens communication control unit **111** transmits the information to the camera communication control unit **142** on a frame-by-frame basis at the timing of a communication timing **441**.

[0129] The camera communication control unit **142** transfers one frame's worth of the position information from the image stabilization lens position sensor **106** to the stabilization position extracting unit **204**. The stabilization position extracting unit **204** extracts position information **440***a* to **440***c* of the subject exposure periods corresponding to the subject lines **407**, which itself corresponds to the subject extracted by the subject position detection unit **161**, from the one frame's worth of position information transmitted from the interchangeable lens **100**. The extracted position information **440***a* to **440***c* is transmitted to the subject movement amount detection unit **163**.

[0130] The subject movement amount detection unit **163** detects the movement amount of the subject on the basis of the outputs from the motion vector detection unit **162**, the stabilization position extracting unit **204**, and the camera shake detection unit **134**.

[0131] According to the sixth embodiment as described thus far, an accurate amount of correction for the image stabilization mechanism can be obtained, which makes it possible to find a more accurate subject movement amount.

[0132] Although the present embodiment describes a method of determining the extraction timing for each horizontal readout line in the image sensor **150**, the extraction may occur for the horizontal readout line every set interval instead.

Seventh Embodiment

[0133] A seventh embodiment of the present invention will be described next with reference to FIGS. **17** to **19**.

[0134] FIG. **17** is a block diagram illustrating, in further detail, a configuration used for a subject movement detection process according to the seventh embodiment of the present invention. Note that elements that are the same as those illustrated in FIG. **15** are given the same reference numerals, and will not be described. The configuration illustrated in FIG. **17** is different from the configuration illustrated in FIG. **15** in that the camera body **120** does not include the stabilization position extracting unit **204**.

[0135] Control according to the seventh embodiment will be described with reference to FIG. **18**. In the seventh embodiment, the position information from the image stabilization lens position sensor **106** is extracted at the timing described in the second embodiment with reference to FIG. **6**. The timing notifying unit **201** outputs the signal **603** indicating the timing at which the position information from the camera stabilization position sensor **131** is to be extracted, and the signal **603** is transmitted to the lens communication control unit **111** from the camera communication control unit **142** through lens communication.

[0136] On the basis of the signal **603**, the lens stabilization position extracting unit **215** extracts the position information from the image stabilization lens position sensor **106** at time t**71** in the exposure period **602***a*, at time t**73** in the exposure period **602***b*, and at time t**74** in the exposure period **602***c*. The lens stabilization position extracting unit **215** then transmits the position information to the camera communication control unit **142** via the lens communication control unit **111**, with the position information extracted at time t**71**

being transmitted at time t**72**, the position information extracted at time t**73** being transmitted at time t**74**, and the position information extracted at time t**75** being transmitted at time t**76**.

[0137] FIG. **19** illustrates the extraction timing when the two subjects **706** and **707** are present in the shot image **705**. The position information from the image stabilization lens position sensor **106** is extracted at the timing described with reference to FIG. **7**. The timing notifying unit **201** outputs the signal **703** indicating the timing at which the position information from the camera stabilization position sensor **131** is to be extracted, and the signal **703** is transmitted to the lens communication control unit **111** from the camera communication control unit **142** through lens communication.

[0138] In the exposure period **702***a*, the lens stabilization position extracting unit **215** extracts the position information from the image stabilization lens position sensor **106** at time t**77**, which corresponds to the subject **707**, on the basis of the signal **603**. The extracted position information is then transmitted to the camera communication control unit **142** via the lens communication control unit **111** at time t**78**. Furthermore, the position information from the image stabilization lens position sensor **106** is extracted at time t**79**, corresponding to the subject **706**, and the extracted position information is transmitted to the camera communication control unit **142** via the lens communication control unit **111** at time t**80**. The position information is extracted and transmitted through the same processing in the exposure periods **702***b* and **702***c* as well.

[0139] The position information from the image stabilization lens position sensor **106**, which is transmitted in this manner, is transmitted to the subject movement amount detection unit **163** and used to detect the movement amount of the subject.

[0140] According to the seventh embodiment as described thus far, an accurate amount of correction for the image stabilization mechanism can be obtained, which makes it possible to find a more accurate subject movement amount.

Eighth Embodiment

[0141] An eighth embodiment of the present invention will be described next with reference to FIGS. **20** and **21**.

[0142] FIG. **20** is a block diagram illustrating, in further detail, a configuration used for a subject movement detection process according to the eighth embodiment of the present invention. According to the configuration illustrated in FIG. **20**, the position information from the image stabilization lens position sensor **106** is extracted at the timing described with reference to FIG. **18** or **19**, image stabilization is carried out using the image sensor **150**, and the position information from the camera stabilization position sensor **131** is extracted at the timing described with reference to FIG. **6** or **7**. In FIG. **20**, elements that are the same as those illustrated in FIGS. **5** and **15** are given the same reference numerals, will not be described. Furthermore, the elements in FIG. **1** not directly related to the subject movement detection process according to the eighth embodiment are not shown.

[0143] Control according to the eighth embodiment will be described with reference to FIG. **21**. Like FIG. **18** described in the seventh embodiment, a situation where a single subject **606** has been detected will be described here.

[0144] As illustrated in FIG. **21**, the camera stabilization position sensor **131** and the image stabilization lens position sensor **106** extract the position information at the same timing. Furthermore, like the example illustrated in FIG. **6**, the timing notifying unit **201** determines time t**81**, which coincides with the center of the subject exposure period **608**, as the extraction timing, and outputs the signal **903** to the stabilization position extracting unit **204**. In response to the signal **903**, the stabilization position extracting unit **204** extracts the position information from the camera stabilization position sensor **131** at time t**81**, and transmits the extracted position information to the subject movement amount detection unit **163**.

[0145] On the other hand, the timing notifying unit **201** transmits a signal **904**, for causing the position information to be extracted at time t**81**, to the lens communication control unit **111** from the camera communication control unit **142**, through lens communication. In response to the signal **904**, the lens stabilization position extracting unit **215** extracts the position information from the image stabilization lens position sensor **106** at time t**81**, and passes the extracted position information to the lens communication control unit **111**. The lens communication control unit **111** transmits the information of the image stabilization lens position sensor **106** to the camera communication control unit **142** at time t**82**, through lens communication. The camera communication control unit **142** transmits the received information to the subject movement amount detection unit **163**. The above-described processing is carried out for the exposure periods **602***b* and **602***c* as well.

[0146] The subject movement amount detection unit **163** obtains the motion vector calculated from the image from the motion vector detection unit **162**. The shake amount of the image capturing apparatus is obtained from the camera shake detection unit **134**. Furthermore, the position information of the image stabilization mechanism is obtained from the stabilization position extracting unit **204** and the lens stabilization position extracting unit **215**. The accurate position information of the subject can be found from this information.

[0147] According to the eighth embodiment as described thus far, extracting the position information of the image stabilization mechanisms in accordance with the exposure period of a subject makes it possible to find an accurate amount of correction for the image stabilization mechanisms, corresponding to that exposure, in an interchangeable lens-type image capturing apparatus. An accurate movement amount of the subject can be found as a result.

[0148] Note that control may be carried out so that the position information is extracted at the timings illustrated in FIGS. **4**A, **4**B, and **7**.

Ninth Embodiment

[0149] A ninth embodiment of the present invention will be described next with reference to FIGS. **22** and **23**.

[0150] FIG. **22** is a block diagram illustrating, in further detail, a configuration used for a subject movement detection process according to the ninth embodiment of the present invention. Note that elements that are the same as those illustrated in FIGS. **1** and **3** are given the same reference numerals, and will not be described. Furthermore, the elements in FIG. **1** not directly related to the subject movement detection process according to the ninth embodiment are not shown.

[0151] An image capturing control circuit **2201** is a circuit block including the image sensor **150**, the camera stabiliza-

tion control unit **135**, the motion vector detection unit **162**, the subject movement amount detection unit **163**, and the like, and is formed on a single circuit board or semiconductor device. A camera control circuit **2202** is a circuit block including the camera control unit **160**, the camera shake detection unit **134**, and the like, and is formed on a different circuit board or semiconductor device from the image capturing control circuit **2201**.

[0152] An image capturing control unit **2211** is a processing block that controls the image sensor **150**, the exposure timing control unit **152**, the image signal processing unit **151**, and the like, and sets the shooting conditions such as the exposure period, a pixel readout algorithm for the image sensor **150**, and the like.

[0153] A communication control unit **2206** and a communication control unit **2207** are communication blocks for passing image capturing control information from the camera control unit **160** to the image capturing control unit **2211**. The communication control unit **2206** and the communication control unit **2207** are used to pass a camera shake amount output by the camera shake detection unit **134** from the camera control unit **160** to the camera stabilization control unit **135** and a shake amount extracting unit **2205**. For example, if the image capturing control information and the camera shake amount are transferred via separate communication circuits, communication circuits and lines are required for both. This is a problem in that it increases the space required for wiring, the number of connector pins, and the like on the circuit board, which increases the component costs and makes it difficult to keep the image capturing apparatus small. In the present embodiment, an increase in the circuit scale and component cost are suppressed by transferring the image capturing control information and the camera shake amount via the same communication circuit.

[0154] The shake amount extracting unit **2205** extracts the camera shake amount output from the camera shake detection unit **134** at a specific timing. The timing is determined by the output of the timing notifying unit **201** included in the exposure timing control unit **152**.

[0155] Next, the camera shake amount output from the camera shake detection unit **134**, and the timing of the extraction by the shake amount extracting unit **2205**, in a case where the present embodiment is applied, will be described with reference to FIG. **23**. Note that the same signals and the like as those illustrated in FIGS. **4**A and **4**B are given the same reference numerals.

[0156] The camera shake detection unit **134** transmits the detected camera shake amount to the camera control unit **160** at predetermined intervals. In the example illustrated in FIG. **23**, the camera shake amount is transmitted from the camera shake detection unit **134** to the camera control unit **160** at the communication timings **441**, **442**, and so on up to **449**, in that order.

[0157] The camera control unit **160** transmits the received camera shake amounts to the shake amount extracting unit **2205** in sequence. In the example illustrated in FIG. **23**, the camera shake amount received at the communication timing **441** is transmitted from the camera control unit **160** to the shake amount extracting unit **2205** at the communication timing **431**. Likewise, the camera shake amount received at the communication timing **442** is transmitted from the camera control unit **160** to the shake amount extracting unit **2205** at the communication timing **432**; and the camera shake amount received at the communication timing **449**, at the communication timing **439**.

[0158] The shake amount extracting unit **2205** extracts a camera shake amount on the basis of the output from the timing notifying unit **201**, from among the received camera shake amounts. As described with reference to FIGS. **4**A and **4**B, in the ninth embodiment, the extraction timing is set to the central time corresponding to the center of the exposure period of each horizontal readout line in the image sensor **150**. For example, with the uppermost horizontal readout line **411**, the central time of the exposure period is time t**91**, and thus the timing notifying unit **201** notifies the shake amount extracting unit **2205** of time t**91**. The shake amount extracting unit **2205** then extracts the camera shake amount received at the communication timing **431** as the camera shake amount corresponding to time t**91**.

[0159] Likewise, for the horizontal readout line **412**, the shake amount extracting unit **2205** extracts the camera shake amount received at the communication timing **432** as the camera shake amount corresponding to time t**92**. Furthermore, for the horizontal readout line **419**, the shake amount extracting unit **2205** extracts the camera shake amount received at the communication timing **439** as the camera shake amount corresponding to time t**93**. This extraction process is the same for the exposure periods **402***b* and **402***c*, which are the second and third exposure periods, respectively.

[0160] The stabilization position extracting unit **204** also extracts the position information output from the camera stabilization position sensor **131** at the same timing as the shake amount extracting unit **2205**, on the basis of the signal from the timing notifying unit **201**, and transmits the extracted position information to the subject movement amount detection unit **163**.

[0161] According to the ninth embodiment as described above, the camera shake amount corresponding to each horizontal readout line can be found for each of those horizontal readout lines, and the accuracy with which the subject movement amount is detected can be improved as a result.

[0162] Note that the stabilization position extracting unit **204** and the shake amount extracting unit **2205** may be controlled to extract the position information and the camera shake amount at the timings indicated in FIG. **6** or FIG. **7** instead.

Tenth Embodiment

[0163] A tenth embodiment of the present invention will be described next with reference to FIG. **24**. Note that the configuration of the image capturing apparatus according to the present embodiment is the same as that illustrated in FIGS. **1** and **22**, and will therefore not be described.

[0164] FIG. **24** is a diagram illustrating the timing of the extraction by the shake amount extracting unit **2205** according to the tenth embodiment. Note that timings that are the same as those illustrated in FIG. **23**, described above, will be given the same reference signs.

[0165] The camera shake detection unit **134** transmits the detected camera shake amount to the camera control unit **160** at predetermined intervals. In the example illustrated in FIG. **24**, the camera shake amount is transmitted from the camera shake detection unit **134** to the camera control unit **160** at a communication timing **541**, a communication

timing **542**, a communication timing **543**, and so on up to a communication timing **549**, in that order.

[0166] The camera control unit **160** includes memory such as RAM (not shown) for temporarily storing various types of data, and stores the received camera shake amounts in the memory. The camera control unit **160** then transmits the camera shake amounts stored over a predetermined period to the shake amount extracting unit **2205** all at once. In FIG. **24**, the camera control unit **160** transmits the camera shake amounts received at the communication timings **541** to **543** all at once to the shake amount extracting unit **2205** at the communication timing **533**. Likewise, the camera shake amounts from a predetermined period are transmitted from the camera control unit **160** all at once to the shake amount extracting unit **2205**, at the communication timings **536** to **539**, in that order.

[0167] The shake amount extracting unit **2205** extracts a camera shake amount on the basis of the output from the timing notifying unit **201**, from the camera shake amounts received all at once. Like the ninth embodiment, in the tenth embodiment, the extraction timing is set to the central time corresponding to the center of the exposure period of each horizontal readout line in the image sensor **150**. For example, with the uppermost horizontal readout line **411**, the central time of the exposure period is time t**101**, and thus the timing notifying unit **201** notifies the shake amount extracting unit **2205** of time t**101**.

[0168] In the same manner, the timing notifying unit **201** notifies the shake amount extracting unit **2205** of time t**102**, which corresponds to the horizontal readout line **412**, and time t**103**, which corresponds to the horizontal readout line **413**. The shake amount extracting unit **2205** extracts the camera shake amounts corresponding to time t**101**, time t**102**, time t**103**, and time t**104** from the camera shake amounts received all at once at the communication timing **533**. Likewise, the shake amount extracting unit **2205** extracts the camera shake amount corresponding to the exposure period of each horizontal readout line, from the camera shake amounts received all at once at the communication timings **536** to **539**. This extraction process is the same for the exposure periods **402***b* and **402***c*, which are the second and third exposure periods, respectively.

[0169] The stabilization position extracting unit **204** also extracts the position information output from the camera stabilization position sensor **131** at the same timing as the shake amount extracting unit **2205**, on the basis of the signal from the timing notifying unit **201**, and transmits the extracted position information to the subject movement amount detection unit **163**.

[0170] The communication of the image capturing control information and the camera shake amount is carried out through the communication control unit **2206** and the communication control unit **2207**, and thus control for ensuring that the communication timings of the image capturing control signals and the camera shake amounts do not overlap is necessary. According to the present embodiment, communicating the camera shake amounts all at once makes it easy to control the communication timings of the image capturing control signals and the camera shake amounts.

[0171] Note that the stabilization position extracting unit **204** and the shake amount extracting unit **2205** may be controlled to extract the position information and the camera shake amount at the timings indicated in FIG. **6** or FIG. **7** instead.

[0172] Although the present embodiment describes a configuration in which the camera shake amounts from a predetermined period are transmitted all at once, the configuration may be such that camera shake amounts corresponding to a single frame are transmitted all at once. A configuration is also possible in which the camera shake amounts corresponding to the exposure periods of a single frame are transmitted all at once. For example, the camera shake amounts need not be transmitted to the camera stabilization control unit **135** when the stabilization control is off in the main body. Doing so makes it possible to reduce the frequency at which the camera shake amount is transmitted from the camera control unit **160** to the shake amount extracting unit **2205**. Note that in FIG. **24**, the camera shake amounts corresponding to the exposure period of a single frame correspond to the camera shake amounts detected in the period from the communication timing **541** to the communication timing **549**.

[0173] Furthermore, although the present embodiment describes a configuration in which the camera shake amounts from a predetermined period are transmitted all at once, the configuration may be such that the setting for that predetermined period is changed on the basis of the subject movement amount. For example, if the detection result from the subject movement amount detection unit **163** indicates a high subject movement amount, the predetermined period may be shortened in anticipation of an increased camera shake amount. On the other hand, if the subject movement amount is low, the predetermined period may be lengthened in anticipation of a reduced camera shake amount.

[0174] According to the tenth embodiment as described thus far, a camera shake amount corresponding to the exposure period of the subject can be extracted, which makes it possible to improve the accuracy at which the subject movement amount is detected. Furthermore, the camera shake amount can be passed to the subject movement amount detection unit using a configuration that suppresses an increase in the circuit scale and the component cost.

[0175] Note that the stabilization position extracting unit **204** and the shake amount extracting unit **2205** may be controlled to extract the position information and the camera shake amount at the timings indicated in FIG. **6** or FIG. **7** instead.

Other Embodiments

[0176] Embodiment(s) of the present invention can also be realized by a computer of a system or apparatus that reads out and executes computer executable instructions (e.g., one or more programs) recorded on a storage medium (which may also be referred to more fully as a 'non-transitory computer-readable storage medium') to perform the functions of one or more of the above-described embodiment(s) and/or that includes one or more circuits (e.g., application specific integrated circuit (ASIC)) for performing the functions of one or more of the above-described embodiment(s), and by a method performed by the computer of the system or apparatus by, for example, reading out and executing the computer executable instructions from the storage medium to perform the functions of one or more of the above-described embodiment(s) and/or controlling the one or more circuits to perform the functions of one or more of the above-described embodiment(s). The computer may comprise one or more processors (e.g., central processing unit

(CPU), micro processing unit (MPU)) and may include a network of separate computers or separate processors to read out and execute the computer executable instructions. The computer executable instructions may be provided to the computer, for example, from a network or the storage medium. The storage medium may include, for example, one or more of a hard disk, a random-access memory (RAM), a read only memory (ROM), a storage of distributed computing systems, an optical disk (such as a compact disc (CD), digital versatile disc (DVD), or Blu-ray Disc (BD)™), a flash memory device, a memory card, and the like.

[0177] While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

[0178] This application claims the benefit of Japanese Patent Application No. 2018-188608, filed on Oct. 3, 2018 which is hereby incorporated by reference herein in its entirety.

What is claimed is:

1. An image stabilizing apparatus comprising:

a shake detector that detects shake;

an image stabilizer that corrects the shake by moving a position on the basis of the shake detected by the shake detector;

a position detector that detects and outputs the position of the image stabilizer;

a determinator that determines an extraction timing at which to extract the position of the image stabilizer on the basis of a timing at which an image sensor which shoots an image is exposed; and

an extractor that extracts the position of the image stabilizer, from the output of the position detector, at the extraction timing determined by the determinator.

2. The image stabilizing apparatus according to claim **1**,

wherein a plurality of pixels are arranged in the image sensor in a matrix; and

the determinator determines a central time of an exposure period for each line in the image sensor as the extraction timing.

3. The image stabilizing apparatus according to claim **1**,

wherein a plurality of pixels are arranged in the image sensor in a matrix; and

the determinator determines a central time of an exposure period for each line at a set interval, among the lines in the image sensor, as the extraction timing.

4. The image stabilizing apparatus according to claim **1**, further comprising:

a subject position detector that detects a position of a subject from an image captured by the image sensor,

wherein a plurality of pixels are arranged in the image sensor in a matrix; and

for each subject detected by the subject position detector, the determinator determines a central time of an exposure period of a line including the subject as the extraction timing for that subject.

5. The image stabilizing apparatus according to claim **1**, further comprising:

a smoothing circuit that carries out a smoothing process on time series information of the position of the image stabilizer output from the position detector,

wherein the extractor extracts the position of the image stabilizer at the extraction timing determined by the determinator, from the smoothed time series information of the position of the image stabilizer.

6. The image stabilizing apparatus according to claim **1**,

wherein the image stabilizer is an image sensor.

7. The image stabilizing apparatus according to claim **1**, further comprising:

a second shake detector that detects shake;

a second image stabilizer that corrects the shake by moving a position on the basis of the shake detected by the second shake detector;

a second position detector that detects and outputs the position of the second image stabilizer; and

a second extractor that extracts the position of the second image stabilizer, from the output of the second position detector, at the extraction timing determined by the determinator.

8. The image stabilizing apparatus according to claim **7**,

wherein the second image stabilizer is an image stabilization lens.

9. The image stabilizing apparatus according to claim **7**,

wherein the image stabilizing apparatus is provided in an image capturing system constituted by a main body of an image capturing apparatus and an interchangeable lens;

the interchangeable lens includes the second shake detector, the second image stabilizer, the second position detector, and the second extractor, and the main body of the image capturing apparatus includes the image sensor and the determinator; and

the apparatus further comprises communication circuits one of which transmits the extraction timing determined by the determinator to the interchangeable lens, and the other of which transmits the position of the second image stabilizer extracted by the second extractor to the main body of the image capturing apparatus.

10. The image stabilizing apparatus according to claim **1**,

wherein the image stabilizer is an image stabilization lens.

11. The image stabilizing apparatus according to claim **10**,

wherein the image stabilizing apparatus is provided in an image capturing system constituted by a main body of an image capturing apparatus and an interchangeable lens;

the interchangeable lens includes the shake detector, the image stabilizer, the position detector, and the extractor, and the main body of the image capturing apparatus includes the image sensor and the determinator; and

the apparatus further comprises communication circuits one of which transmits the extraction timing determined by the determinator to the interchangeable lens, and the other of which transmits the position of the image stabilizer extracted by the extractor to the main body of the image capturing apparatus.

12. The image stabilizing apparatus according to claim **1**, further comprising:

a third extractor that extracts the output of the shake detector at the extraction timing determined by the determinator.

13. The image stabilizing apparatus according to claim **12**,

wherein the shake detector is formed on a different circuit board from the determinator and the third extractor; and

the apparatus further comprises a communication circuit that transmits information of the shake detected by the shake detector to the third extractor.

14. The image stabilizing apparatus according to claim **13**,

wherein the communication circuit transmits the information of the shake sequentially to the third extractor.

15. The image stabilizing apparatus according to claim **13**,

wherein the communication circuit transmits the information of the shake obtained in each predetermined period to the third extractor all at once.

16. The image stabilizing apparatus according to claim **1**,

wherein the image stabilizing apparatus is formed on the same circuit board as the image sensor.

17. The image stabilizing apparatus according to claim **1**, further comprising:

a generator that generates a packet, containing a payload and a header, the packet including pixel data of an image captured by the image sensor in which a plurality of pixels are arranged in a matrix, and information of the position of the image stabilizer extracted by the extractor; and

a transmitter that transmits the packet generated by the generator.

18. The image stabilizing apparatus according to claim **17**,

wherein the generator inserts the pixel data from each line of the image sensor into the payload of a corresponding packet, and inserts the information of the position of the image stabilizer extracted by the extractor in the exposure period of that line into the header of the same packet.

19. The image stabilizing apparatus according to claim **17**,

wherein on the basis of the output of the position detector, the generator finds a reference position of the image stabilizer in each of frames and a difference between the position of the image stabilizer and the reference position, inserts the pixel data of each line in the image sensor or information of the reference position into the payload of each packet, and inserts information of the difference into the header of the line corresponding to the extraction timing at which the position of the image stabilizer was extracted.

20. The image stabilizing apparatus according to claim **17**,

wherein the generator inserts the pixel data of each line in the image sensor or information of the position of the image stabilizer into the payload of each packet, and inserts, into the header of each packet, information indicating which of the pixel data of each line in the image sensor or the information of the position of the image stabilizer is inserted into the payload.

21. The image stabilizing apparatus according to claim **17**,

wherein the image sensor includes a dummy region that does not output pixel data; and

the generator inserts information of the position of the image stabilizer into the payload of a packet corresponding to the dummy region, and inserts, into the header of that packet, information indicating that the information of the position of the image stabilizer has been inserted.

22. An image processing apparatus comprising:

a motion vector detector that detects a motion vector indicating movement of a subject on the basis of an image captured by an image sensor; and

an acquisition circuit that acquires the motion vector detected by the motion vector detector and information from an image stabilizing apparatus;

a moving amount detector that detects a movement amount of the subject on the basis of the information acquired by the acquisition circuit,

wherein the image stabilization apparatus comprising:

a shake detector that detects shake;

an image stabilizer that corrects the shake by moving a position on the basis of the shake detected by the shake detector;

a position detector that detects and outputs the position of the image stabilizer;

a determinator that determines an extraction timing at which to extract the position of the image stabilizer on the basis of a timing at which an image sensor which shoots an image is exposed; and

an extractor that extracts the position of the image stabilizer, from the output of the position detector, at the extraction timing determined by the determinator, and

wherein the information includes a shake amount detected by the shake detector and the position of the image stabilizer extracted by the extractor.

23. A method of detecting a position of an image stabilizer, the method comprising:

detecting shake;

correcting the shake by moving the position of the image stabilizer on the basis of the detected shake;

detecting and outputting the position of the image stabilizer;

determining an extraction timing at which to extract the position of the image stabilizer on the basis of a timing at which an image sensor which shoots an image is exposed; and

extracting, from the detected position of the image stabilizer, the position of the image stabilizer at the determined extraction timing.

24. A computer-readable storage medium storing a program that,

in an image stabilizing apparatus including a shake detector that detects shake, an image stabilizer that corrects the shake by moving a position on the basis of the shake detected by the shake detector, and a position detector that detects and outputs the position of the image stabilizer,

causes a computer to function as:

a determinator that determines an extraction timing at which to extract the position of the image stabilizer on the basis of a timing at which an image sensor which shoots an image is exposed; and

an extractor that extracts the position of the image stabilizer, from the output of the position detector, at the extraction timing determined by the determinator.

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